WIRE AND WIRE PRODUCTS

OCTOBER, 1961

"Quick on the Draw!"

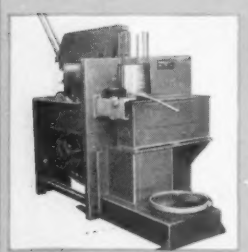
IN EVERY COLD DRAWING AREA THROUGHOUT INDUSTRY AND THE FREE WORLD

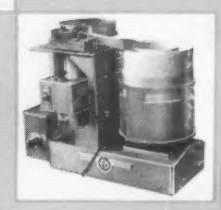
THE VAUGHN MACHINERY COMPANY
CUYAHOGA FALLS, OHIO, U.S.A.

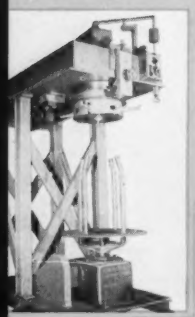
See pages 1361, 1362, 1363 & 1364

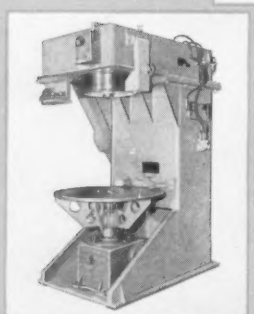
OFFICIAL PUBLICATION OF THE WIRE ASSOCIATION

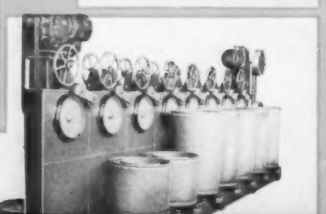
STANDARD OF THE WIRE INDUSTRY

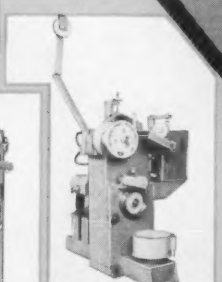












This equipment manufactured under one of the following U. S. Patents 2,732,060; 2,868,474; 2,844,416; 2,868,268; 2,981,494 or others pending.

DRAW-PAK MACHINES

A variety of continuous, constant tension, wire drawing and packing equipment handling from .008" to .375" diameters, in 200 to 2000 lb. (or larger) drums or adapters.

VARI-COILERS

A line of versatile wire take-up and packaging machines with coil ranges from 16" to 36", "non-stop" changing, capacity to 3/8" diameter high carbon steel. Available in multiple units, dove-tailed to your production line.

ATTACHMENTS

Quickly attachable and detachable, adapting your present equipment to packaging 500 lbs. or more in fibre containers. Non-powered, these attachments synchronize with your operation by coupling to any vertical or horizontal block.

DRAW BLOCKS

High speed wire drawing unit in the .016" to .312" range, with constant wire flow into drums of 700 lbs. A choice of die boxes for wet or dry drawing with adjustable, pre-determined cast & pitch control.

RE-WINDERS

Drum or spool take-ups and re-winders adjust for tension, pitch, and amplitude of traverse feeding up to 12" spools and 150 lb. drums.

TAKE-UPS

C & M take-ups can be furnished in gangs operated by single or multiple drive for use in enameling, annealing, tinning, galvanizing, or your specialized operation.

WRITE OR TELEPHONE FOR FURTHER INFORMATION

Barron & Crowther Ltd., Eastleigh, Hants, England. European Draw-Pak Licensee Idos Industries Ltd., Royston, Herts, England, Sales Agents.

SINCE 1843

COULTER & McKENZIE

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YOU and YOUR WIFE

to

"Swing and Sway the Standard Way"

in

The Tag Room
French Lick-Sheraton Hotel
French Lick, Ind.
during
The Annual Wire Association Convention
OCTOBER 22 THRU THE 26

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Kent — Eric
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Member WAS

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Canadian Manufacturer:
H. L. Blachford Ltd., 977 Aqueduct St., Montreal, Que.
H. L. Blachford Ltd., 40 Titan Rd., Toronto, Ont.

Standard Industrial has pioneered in most of the outstanding contributions to better wire drawing through better lubricants. Consult Standard Industrial for the solution of your difficult problems.

HOW TEAMWORK MET GOVERNMENT SPECIFICATIONS FOR MISSILE CABLE APPLICATION

Berkshire Electric Cable Co., Leeds, Massachusetts, leading manufacturer of electric cable for aircraft and electronics, called on The Blane Corporation, Canton, Mass., to develop a vinyl insulation compound to meet the specifications of MILW 16878C, types B, C, and D.

Berkshire specified that the compound must meet the thin wall as well as heavy wall applications, requiring a temperature range of 105° to −55° C, with an excellent margin of safety.

The result of Blane's insulation specialists working closely with Berkshire engineers is Blane No. 2100 Compound. This quality material combining excellent high temperature properties, superior low temperature characteristics, outstanding electrical properties, superbly does the job of meeting MILW 16878C and other government specifications such as MILW 5086A and NAS 702.

We invite other wire and cable manufacturers to avail themselves of the services of the Blane Research and Development Program without obligation.

Using the Blane Teamwork approach can produce results that spell progress and profit for your company.

HUSKY • CABLE

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ELECTRIC CABLE CO.

THE BLANE CORPORATION
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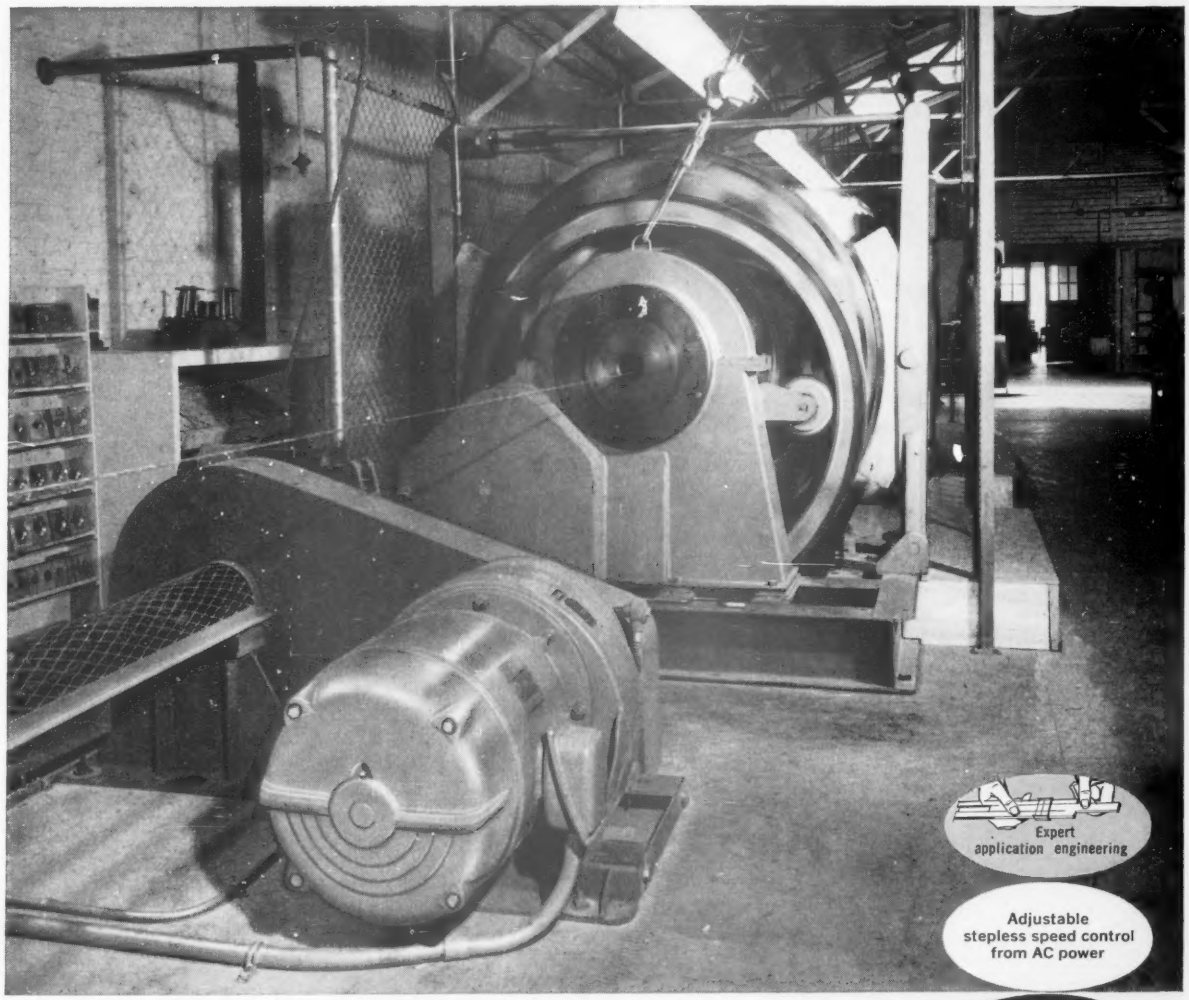

Stepless speed control provides the right twist for cabler

Louis Allis Ajusto-Spede® Drive automatically adjusts speed and/or tension for twisting fine strands into multi-conductor cable

Significant product improvement can be made in cable production if your cablers and other wire processing equipment are equipped with Louis Allis Ajusto-Spede drives and control, like the 50 hp unit shown above.

Here's how it works: You just select the speed you want, and the Ajusto-Spede delivers it steplessly. The drive glides into top speed because acceleration is precisely controlled at all times. The result: proper tension on wires for high-speed cable production with a minimum of strand breakage, downtime, and waste.

The Louis Allis Ajusto-Spede Drive can bring you the same benefits wherever you need precise control of adjustable speed and/or tension to make or process wire. Other applications include wire drawing machines, stranders, extruders, capstans, wind-ups, etc.

Let Louis Allis tailor the Ajusto-Spede drive for one machine — or to provide precise "one dial" master speed control for a multi-drive system. Sizes from 1 to 100 hp, with a broad range of electrical and mechanical modifications to meet your needs.

Contact your nearby Louis Allis District Office for further information and application help, or write for Bulletins 2750 and 2800 to the Louis Allis Company, 451 East Stewart Street, Milwaukee 1, Wisconsin.

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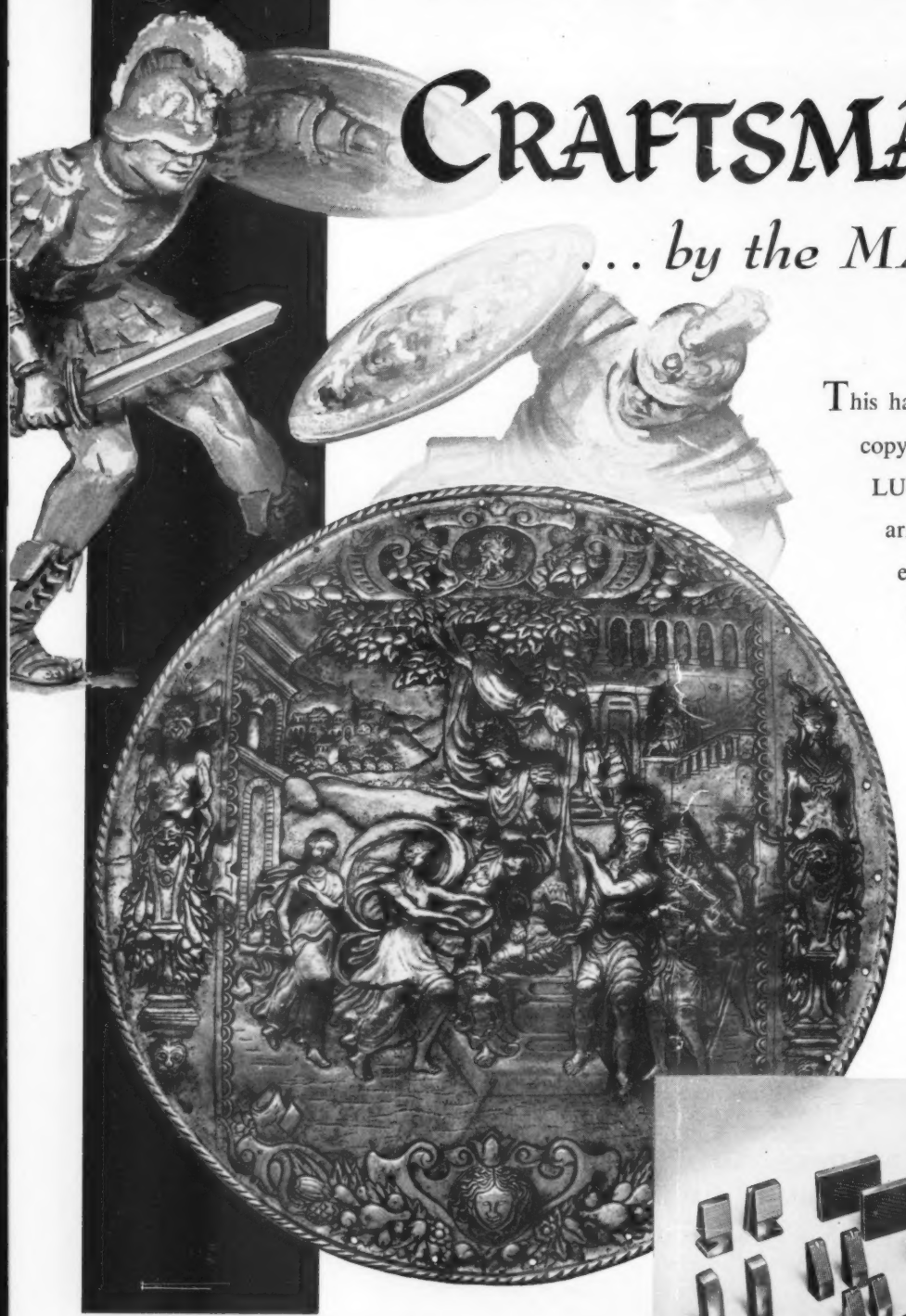
LOUIS ALLIS

AS-214

MANUFACTURER OF ELECTRIC MOTORS AND ADJUSTABLE SPEED DRIVES

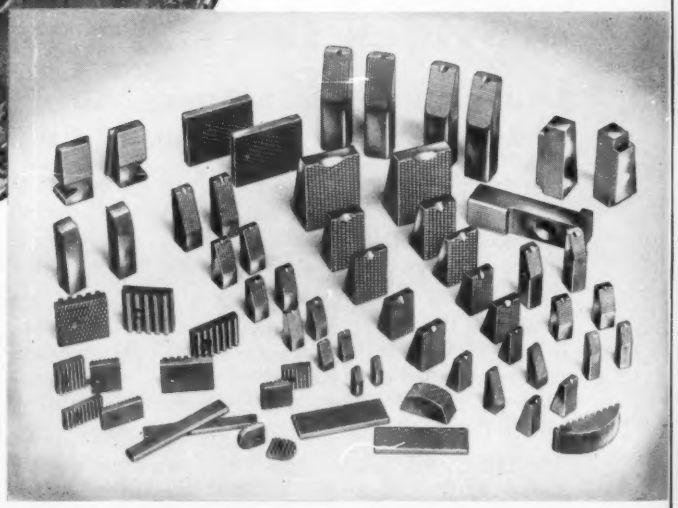
CRAFTSMANSHIP

... by the MASTERS



This hand hammered shield is a fine copy of the original work of LUCIO PICCININO, Italian armorer. The original is on exhibition at the Hermitage, Leningrad and illustrates the expert craftsmanship of these masters who beat a pattern into steel by the repousse method.

16th Century Parade Shield
Photo—courtesy of the John Woodman Higgins Armory, Worcester, Mass.



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WIRE AND WIRE PRODUCTS*

A monthly publication devoted to the production of Wire, Rod and Strip, Wire and Rod Products and Insulated Wire and Cable.
DRAWING — ROLLING — EXTRUDING — FORMING — FABRICATING

Vol. 36 October, 1961 No. 10

Designated as Official Publication By The Wire Association

Contents

The Wire Outlook 1319

Wire Electrogalvanizing Process at The Steel Company of Canada Ltd. Dominion Works
by N. M. Switucha 1321

Continuous Conveyorized Loop Processing—A New Concept in Rod and Wire Handling
by John Zouck 1333

Wire Coating with Polyethylene Resins: Improvement in Extrudate Quality by Using Sensitive Instrumentation
by Dr. F. H. Skewis 1338

Production and Characteristics of Chemically Purified Hydrogen Precipitated Copper Powder
by Jack F. Whitaker 1346

Progress Report on the New Model 7 Properzi Equipment for the Continuous Casting and Rolling of Copper, Aluminum and Zinc
by James B. Russell 1349

Low Stress Elongation (LSE) Testing of Copper Wire
by Matti J. Saarivirta 1370

Oil Tempering High Carbon Spring Wire with a Nitrogen Atmosphere Hardening Furnace
by A. I. Cidonio 1374

The Properties of Copper-Titanium Alloys
by William B. Steward, Jr., and James J. Powers, Jr. 1378

Semiconductive Compounds for Wire and Cable Extrusion
by A. E. Tarbox 1385

The Processing of Steel into Cold Heading Wire
by Robert W. Davis 1338

Controlling Quality of the Surface of Wire by Nondestructive Tests
by Henry G. Bogart 1393

Variable Back-Twist in Rope Making Machinery
by Hans-Werner Schinke 1398

The Swing to Aluminium for Electric Wires and Cables in India
by V. G. G. Nayar and S. Peer Mohammed 1403

Wire Kinks ..... 1409 and 1411

Wire Association Convention Program, etc. 1412-1419

Insulating Wire and Cable with Silicone Rubber
by Donald R. Say 1420

Outstanding Personalities of the Wire Industry 1428

Index to Advertisers ..... 1476 and 1477

Where-to-Buy 1478-1482

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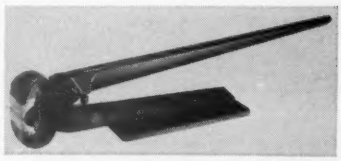
NEW

CAREW BENCH CUTTER



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Doesn't tie up vise or other expensive makeshift

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Smooth Burnished Edges.
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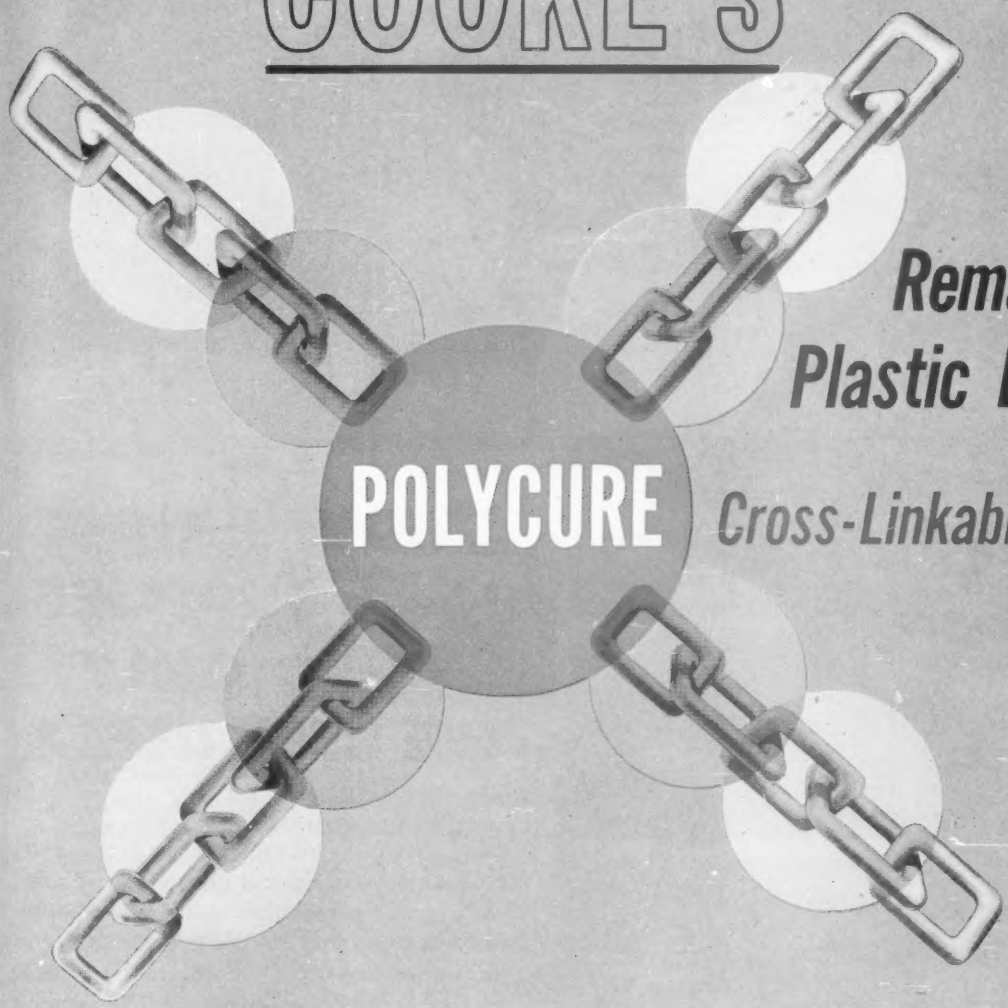

Remarkable New Plastic Development

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POLYCURE is the latest from Cooke - a Vulcanizable Polyethylene, licensed under U. S. Patent No. 2,888,424. This new compound is available in colors as well as black for applications requiring better properties as listed below.

Write today for detailed POLYCURE information.

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- **Ozone Resistant**
- **Chemical Resistant**
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- **Compact and Light Weight Construction**
- **Heat Stability and Ageing**
- **Electrical Property**
- **High and Low Temperature Resistant**
- **Stress Crack Resistant**
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Saw mill at Bradford, N. H., where logs are processed into lumber.

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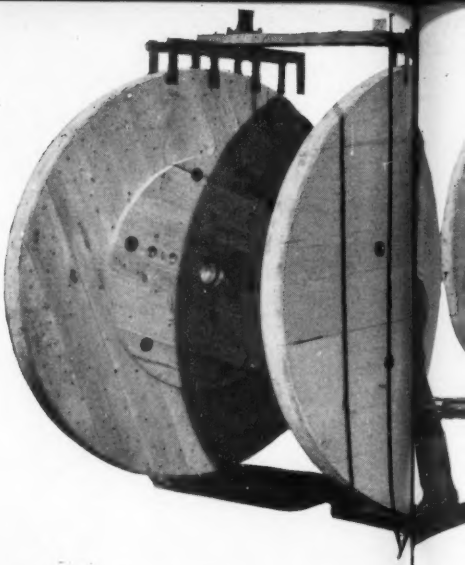


Interior of the Kearsarge plant.

Plant of Kearsarge Reel Co. — an affiliate of Bridge Manufacturing Co.

HOW BRIDGE SUPPLIES ONLY THE BEST REELS

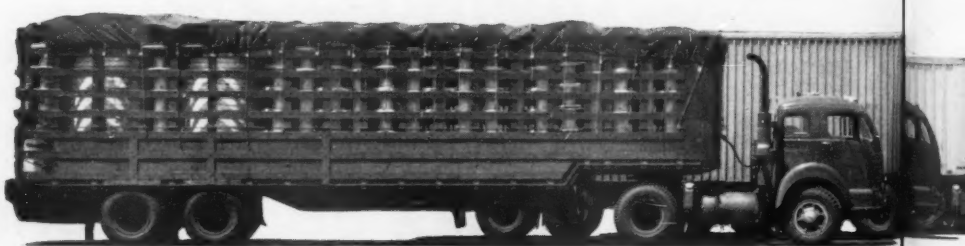
Our company is old, but progressive. Since we began the manufacture of wood reels for wire, rope and electric cable, our plant has undergone a continuous process of expansion and improvement in production facilities — all to the end of making the finest reels and of reducing fabricating costs — listed are some of the factors entering into our ability to serve wire mills effectively and well.

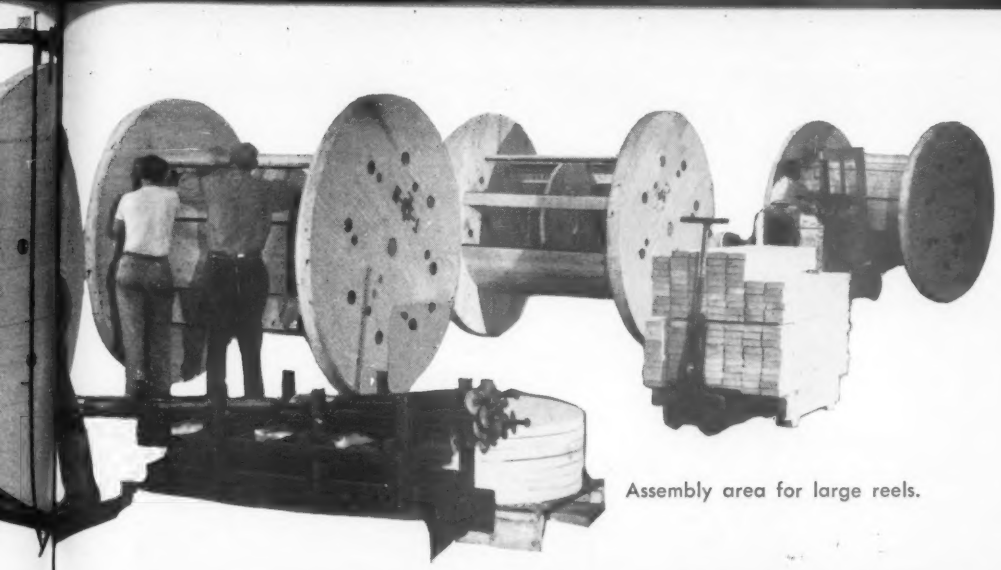
Interior of Hill mill showing manufacture of panels for reel heads.

Hill Box Company's panel mill — another BRIDGE affiliate.

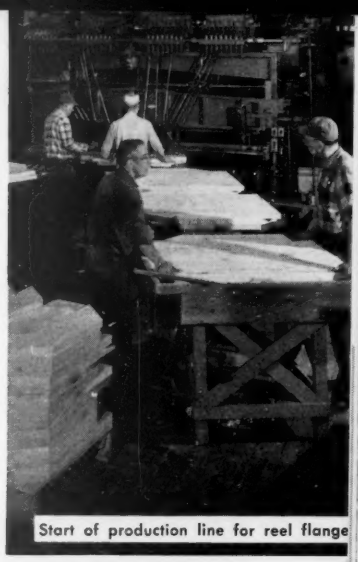
Planing and cutting round-edge lumber

HIGH-SPEED SHIPPING SERVICE IN OUR OWN FLEET OF TRUCKS WITHIN A RADIUS OF 250 MILES FROM THE PLANT.



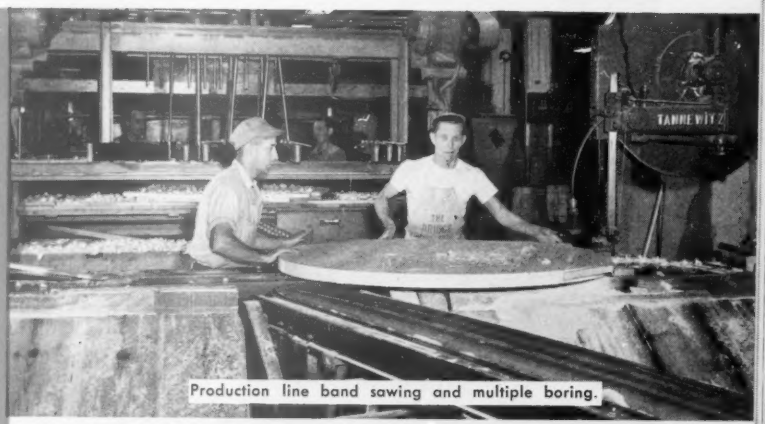


Assembly area for large reels.

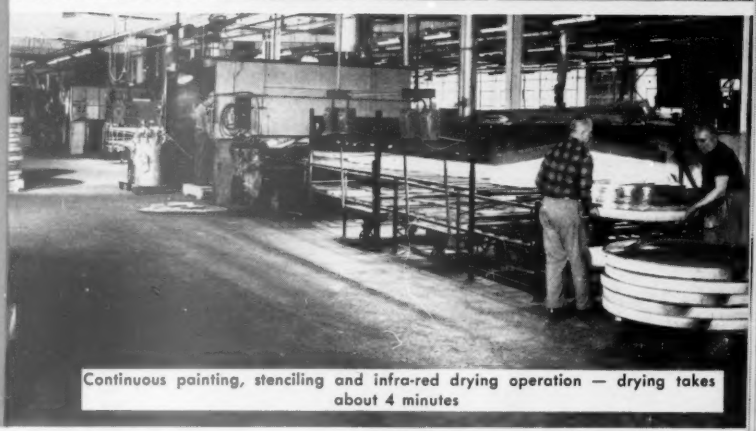


Start of production line for reel flange

- CONTROLLED SAW MILL OPERATIONS.
- CONVERSION OF LUMBER INTO PANELS AND SQUARE-EDGE LUMBER.
- MILLIONS OF BOARD FEET OF LUMBER ALWAYS IN INVENTORY.
- AIR SEASONING OF LUMBER — SUPPLEMENTED BY KILN DRYING.
- EFFICIENT, MODERN MATERIAL HANDLING EQUIPMENT FROM FOREST TO FINISHED REEL.
- LATEST AND FINEST REEL MANUFACTURING MACHINES—MANY MADE TO BRIDGE DESIGNS AND SPECIFICATIONS.
- FABRICATING METHODS CONTINUOUSLY IMPROVED.
- FAST, EFFICIENT STRAIGHT-LINE PRODUCTION FLOW OF WORK.
- PAINTING AND STENCILING COMPLETED IN APPROXIMATELY 4 MINUTES.
- REEL ASSEMBLY METHODS EMPLOY MANY MECHANICAL INNOVATIONS.
- OVERNIGHT DELIVERIES IN OUR OWN TRAILER TRUCKS. FAST FREIGHT USED FOR DISTANT POINTS.



Production line band sawing and multiple boring.



Continuous painting, stenciling and infra-red drying operation — drying takes about 4 minutes

LET US QUOTE YOU ON YOUR REEL NEEDS. SEND US YOUR SPECIFICATIONS. OR BETTER — VISIT OUR PLANT AND SEE HOW BRIDGE REELS ARE MADE.

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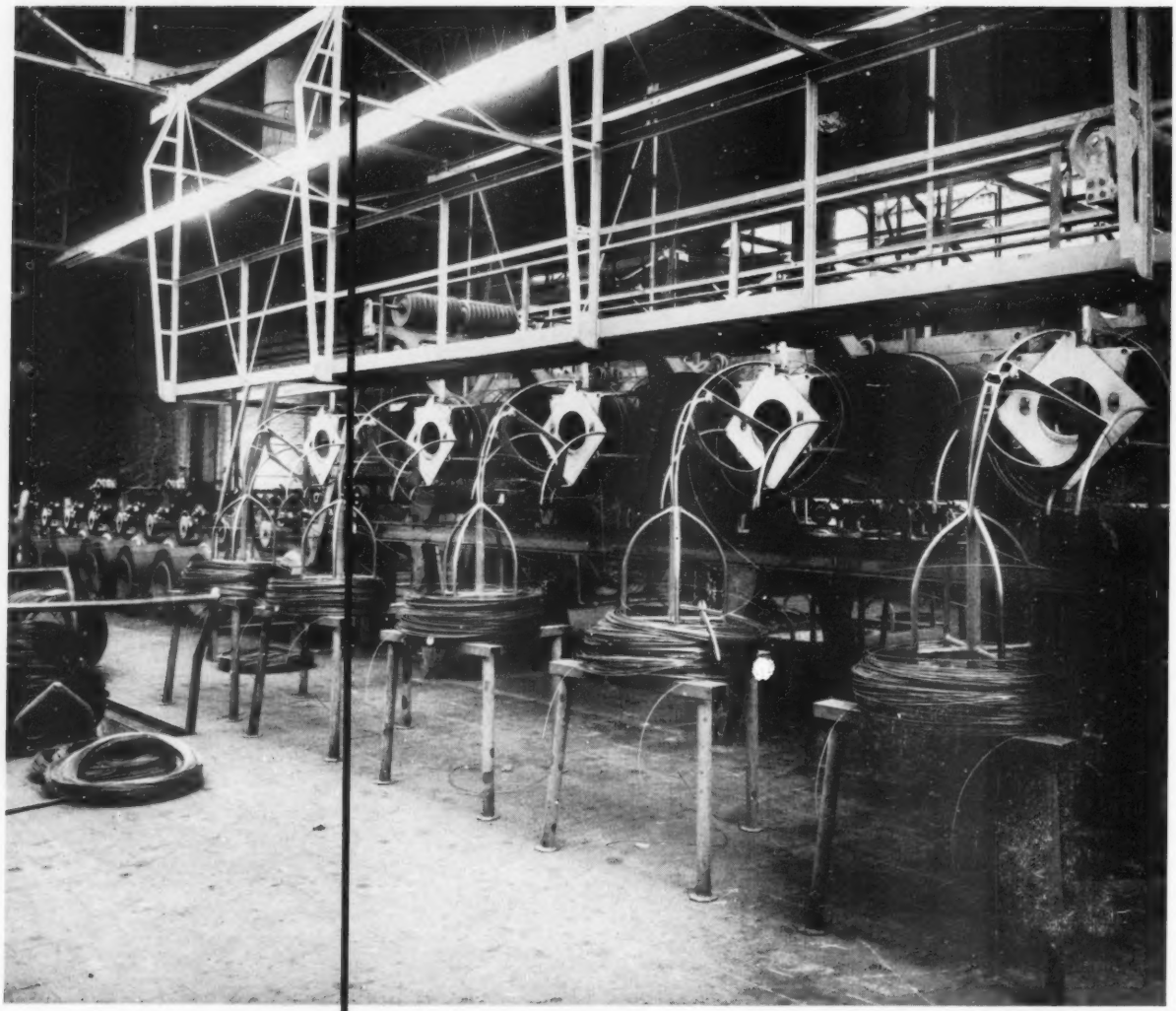
Small reel bench assembly and load area



Wire Takeup Frame (10 stationary blocks), for patented wires, installed above floor level for processing of large coil weights.

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und Eisengiesserei GmbH
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What's your vinyl insulation compounding problem? Whether it's in processing or in arriving at required end properties, PX Job Rated Plasticizers provide a sound solution . . . *at low cost.*

Pittsburgh *primary* plasticizers for the wire industry impart a balanced combination of desirable properties. Elongation retention, tensile strength, resistance to chemical breakdown and to water and oil immersion are some of their outstanding characteristics. And these PX Plasticizers can be compounded to cover temperature ranges from 60°C to 105°C.

Consider quality, check-out economy . . . you'll find that Pittsburgh PX Plasticizers are your best buy. For more PX Plasticizer information or for assistance in developing a solution to your compounding problems, call or drop us a note on your letterhead.

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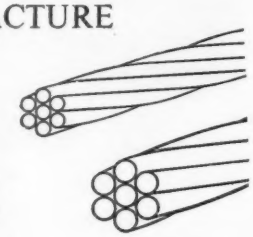

and plain, indented or crimped wires

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Rugged Versatility
WHITACRE TAKE-UP FRAMES

Installation at Colorado Fuel and Iron Corp., Minnequa Works, Pueblo, Colo.

Whitacre Take-Up Frames have gained industry preference because they are rugged and versatile. Heavy duty construction permits 24 hour maintenance-free operation. Wide speed range and interchangeable block sizes allow processing a diversity of products into any type of container with perfect lay and cast. Investigate how Whitacre can lower your production costs.

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U.S. Steel Corp.
Laclede Steel Company
Union Wire Rope, Armco Steel Corp.
Western Electric Co.
Wire Machinery, Inc.

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WHITACRE

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WHITACRE CORPORATION

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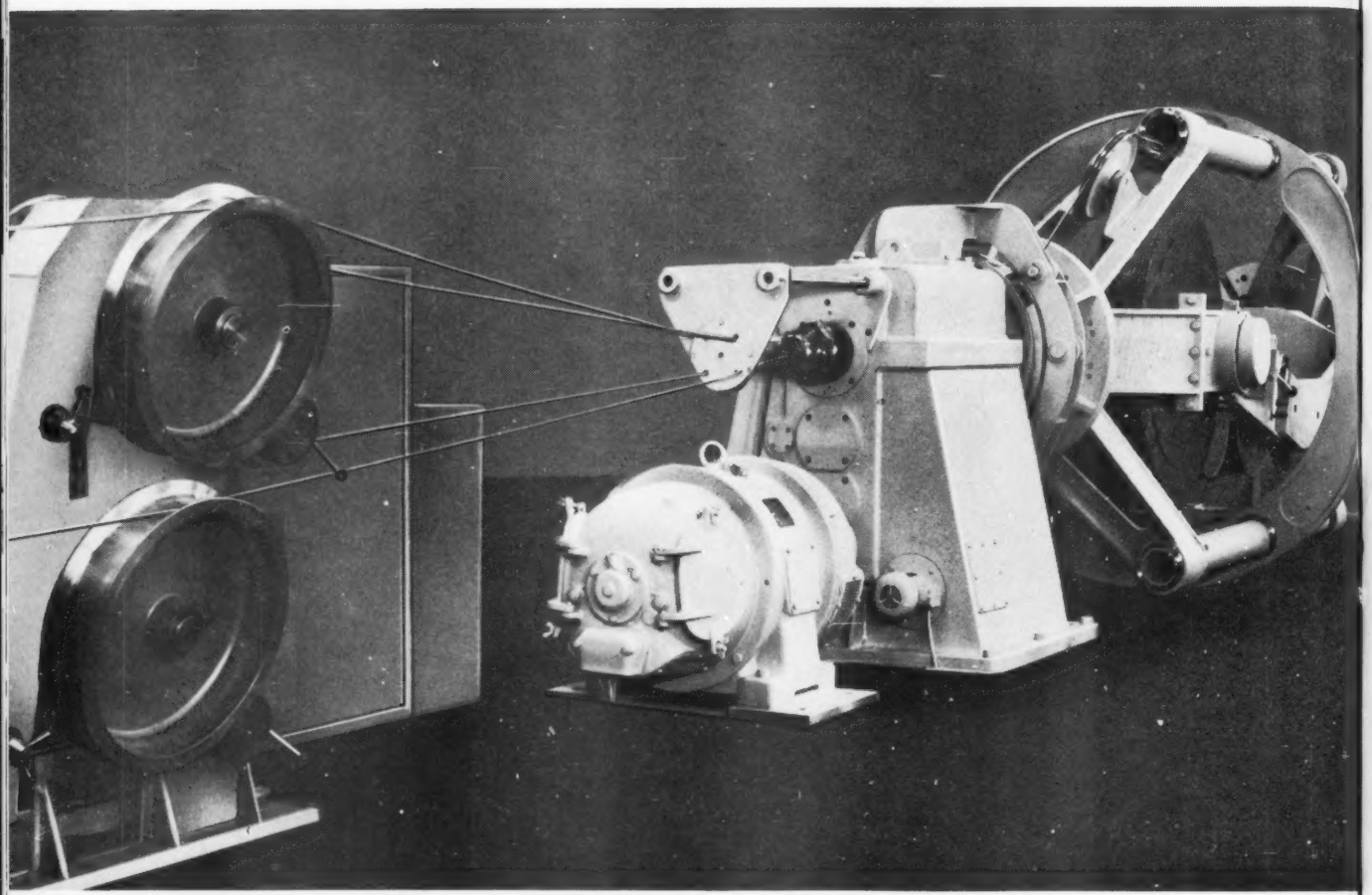
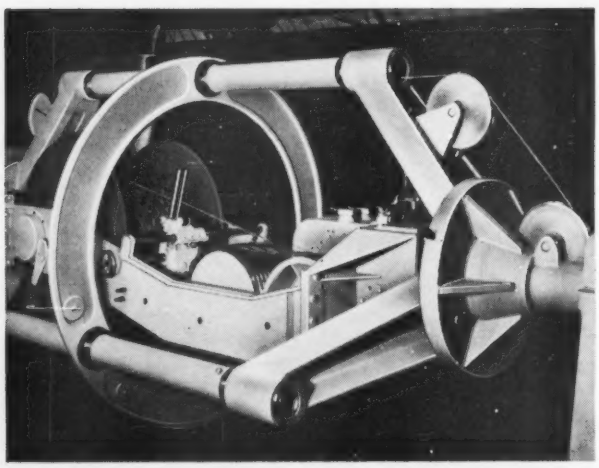
new KRUPP st



FLIER STRANDER HDK 1250 This new Krupp unit works stranding wire of 23 gauge and up into strands of 0.16 inch to 1.2 inch diameter, at speeds of up to 650 RPM



Technical Details: Cradle holds tandem wheel capstan and 50 inch take-up reel. Pulley stand for controlled pay-off tension

Flier speeds 230-300-400 rpm 64 step selective gear box for 1.57 inch to 10.1 inch lay. 65 KW drive

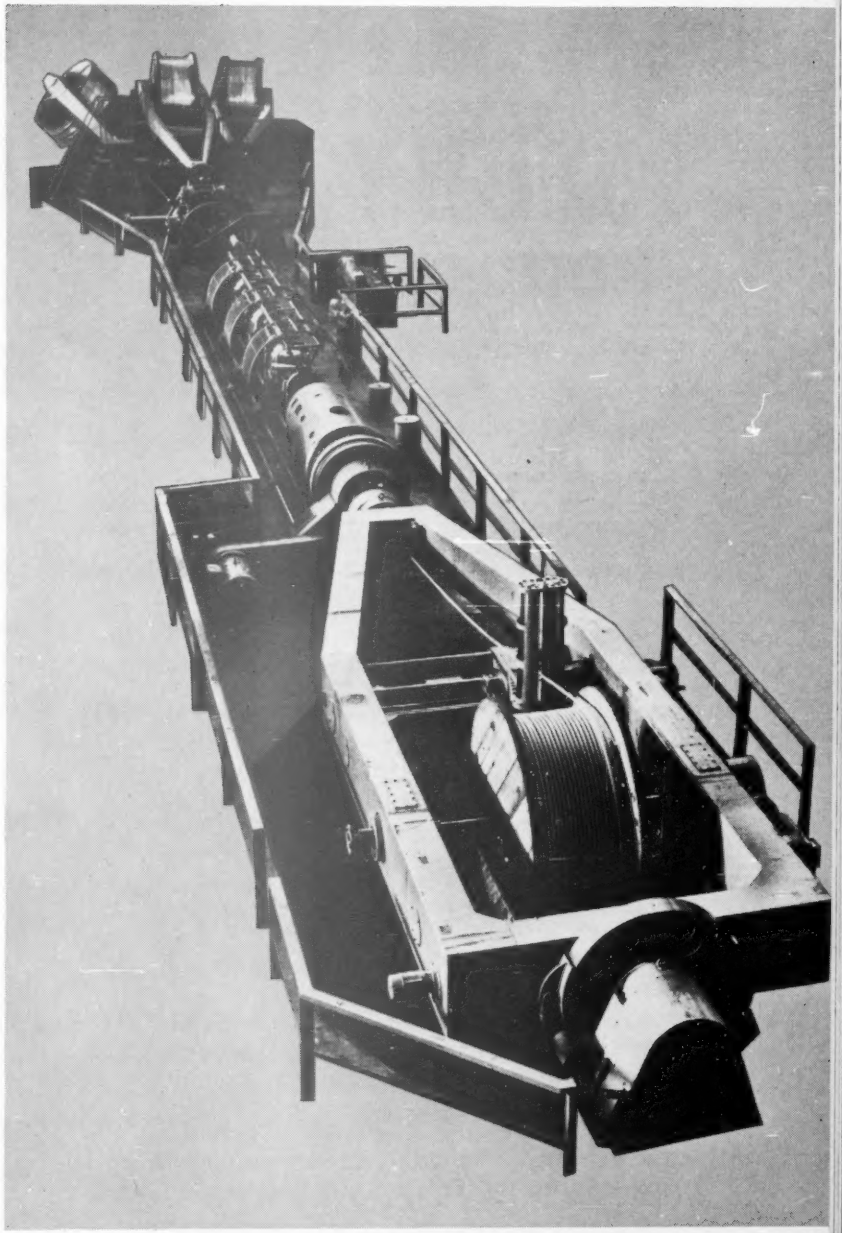
Pstranders and cablers

A NEW CONCEPT IN CABLERS: A rotating capstan and take-up stand instead of a cage with pay-off cradles.

GREATER FLEXIBILITY OF SET-UP AND PRODUCTION: There is practically no limitation to number and size of pay-off stands. All can be positioned for any angle of distribution.

IMPROVED PRODUCT QUALITY: Strands and cable are kept close to the axes of rotation reducing bending strain to a minimum.

IMPROVED EFFICIENCY: High cabling speeds made possible by reduced rotating mass.



UNIVERSAL CABLER UVK 4000 Take-up cradle holding a 156″ reel rotates at up to 25 RPM

150 YEARS
KRUPP
1811-1961

FRIED. KRUPP MASCHINEN- UND STAHLBAU, RHEINHAUSEN, GERMANY

In the Continental U. S. contact: KRUPP INTERNATIONAL INC., 375 Park Avenue, New York 22, N. Y.

Are YOUR Listings Correct in the

WIRE AND WIRE PRODUCTS
BUYERS' GUIDE?

We are beginning to compile the **1962** Edition and must count on YOUR cooperation to keep your listings up-to-date. It is to your advantage to have them accurate.

New products, deletions of products, changes in corporate names and addresses and so forth, should be supplied before the first of the year, if, there have been any. Now's the time to send them in.

These involve

RODS • WIRE • WIRE PRODUCTS • MACHINERY
EQUIPMENT • SUPPLIES • AND SERVICES

There is no charge for listing products and services in light face type. It is a matter of having the directory complete and accurate.

Advertisers' listings will be set in bold face type. If you are not now advertising in the BUYERS' GUIDE and wish to reinforce your listings with advertising, send for a rate card.

The BUYERS' GUIDE is the only directory published in the U.S.A. covering all branches of the Wire Industry. It is widely used as a reference for locating sources of supply. Your cooperation in having YOUR listings correct is solicited.

WIRE AND WIRE PRODUCTS

453 MAIN STREET • **STAMFORD, CONN.**

KEYSTONE WIRE SPEEDS METAL BUILDING ERECTION

Great Lakes Screw Corp. cold heads **Poz-i-seal**®, *the moisture sealing fastener*

Used in the construction of industrial fabricated metal buildings is Poz-i-seal, a sheet metal fastener developed at Great Lakes Screw Corp., Chicago, Ill. It has an indented hex head with Type A point and a hardened steel swivel dome washer, plus rubber seal. Designed to speed building erection, it provides positive seal even when driven at extreme angles.

For this special fastener Great Lakes specifies Keystone's C-1018 Direct Drawn Wire made under closely controlled manufacturing procedures — from open hearth furnace to finished wire.

J. R. Kruizenga, Vice President in Charge of Sales, says, "Keystone Wire flowability and uniform quality keep our high-speed heading machines operating without trouble or delay. Keystone Steel & Wire Company dependable wire deliveries help us maintain an efficient stock control and continuous operation. Keystone service always has been excellent."

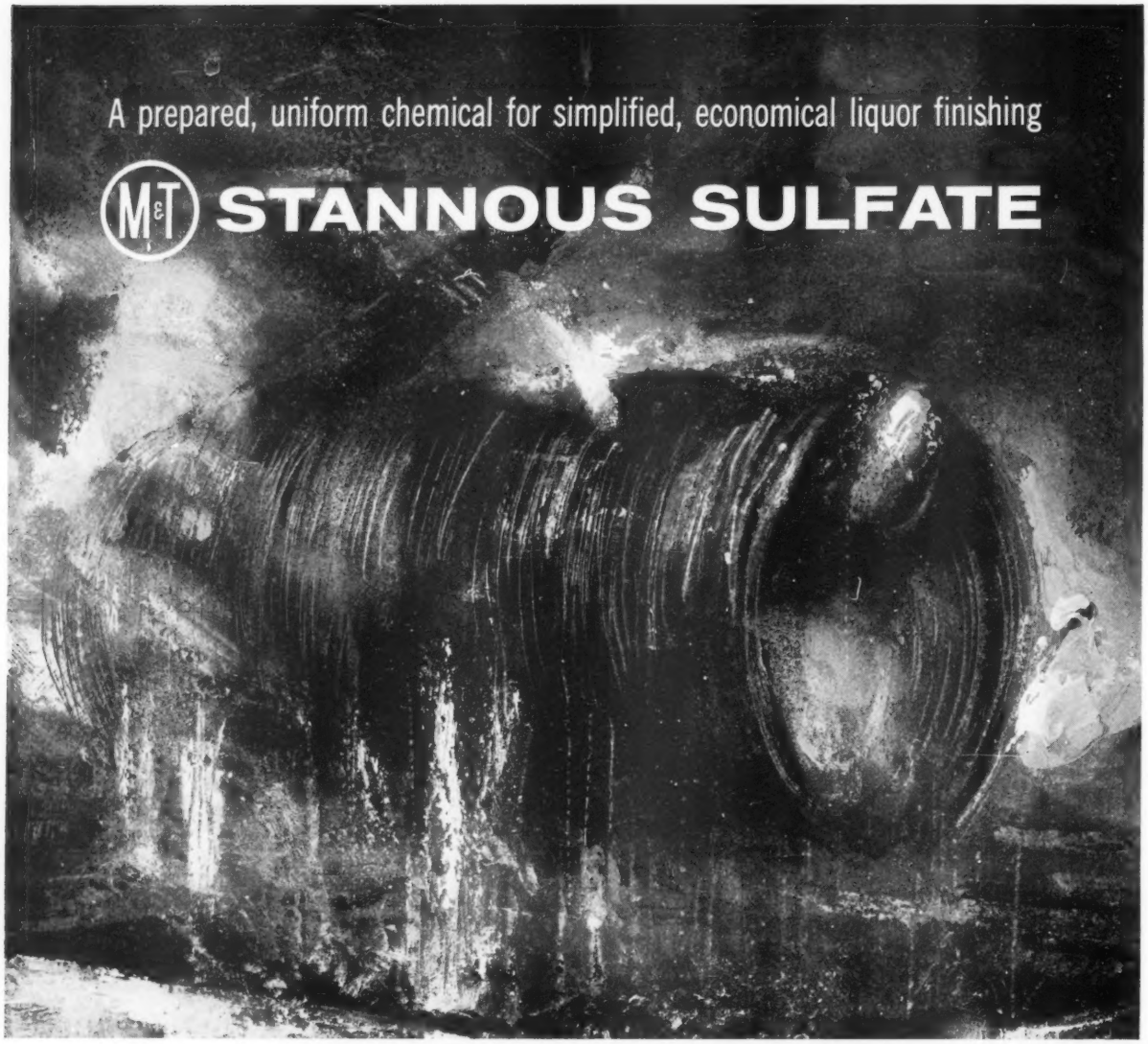
When you need a solution to a wire forming problem, let the Metallurgists at Keystone help you develop a wire to meet your most exacting specifications.

Keystone Steel & Wire Company, Peoria, Illinois

KEYSTONE

· WIRE FOR INDUSTRY

MADE AT PEORIA, ILLINOIS, U.S.A.



EASES PREPARATION
Standard stock solutions can be made up in advance easily and quickly with M&T Stannous Sulfate, a solid, weighable chemical of specified and constant composition. Tin content is divalent, the only form suitable for iron replacement reaction.

SIMPLIFIES CONTROL
Coating weight and color are adjusted accurately and quickly, using stock solutions of known composition.

IMPROVES QUALITY
Composition of solution is consistent from batch to batch . . . tin alloy coatings are smooth and uniform and of pre-determined thickness.

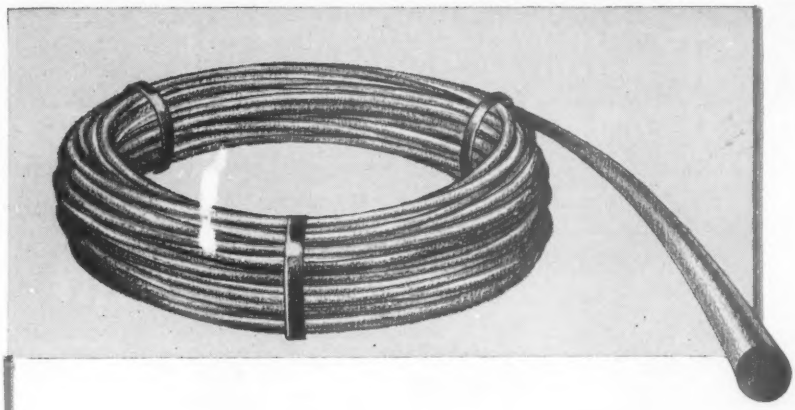
LOWERS COSTS
Standard stock solutions of M&T Stannous Sulfate are more economical to use than solutions prepared from tin metal, copper sulfate and sulphuric acid—save tin and copper, reduce time and labor.

Write for detailed information

M&T Chemicals

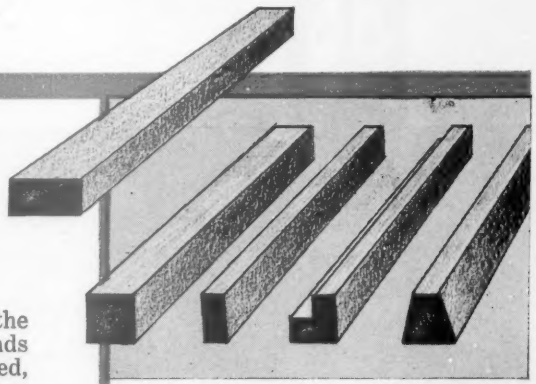
Sn Sb P
Si Ti Zr
organometallics and inorganics

METAL & THERMIT Corporation, Rahway, N. J.
In Canada: M&T Products of Canada Ltd., Hamilton, Ontario



For Your Special Requirements Use

EATON-RELIANCE COLD FINISHED STEELS



Eaton-Reliance can furnish shapes in the range of .020" x .020" to ½" x $\frac{9}{16}$"—rounds up through $\frac{11}{16}$" (coils or bars)—cold rolled, cold drawn special shapes—keystone—centerless ground, finished to your specifications. Produced by the most modern machinery under the most exacting quality control procedures, you can be assured Eaton-Reliance special steels will meet your requirements.

All steel finishing is done in our own mill by experienced craftsmen who draw and roll steel for ball and roller bearings—rings—springs—keys—pins and cold heading. Countless sections are available including round, square, flat, rectangular, step section, keystone and hex.

Eaton-Reliance also cold finishes several non-ferrous metals in addition to carbon, stainless and alloy steels.

Write for our 8-page catalog containing information about Eaton-Reliance cold finished steels and non-ferrous metals. No obligation.

EATON

RELIANCE DIVISION
MANUFACTURING COMPANY
510 CHARLES AVENUE • MASSILLON, OHIO

SALES OFFICES: New York • Cleveland • Detroit • Chicago • St. Louis • San Francisco • Los Angeles

FOR WIRE ROD THAT'S REALLY FINE--

say NIEDERRHEIN

Niederrhein means Quality

Niederrhein, Europe's largest wire rod facility, with its completely modern installations assures close tolerances for diameter and out-of-round, excellent surface and light scale.
Users report exceptionally good mechanical descaling properties.

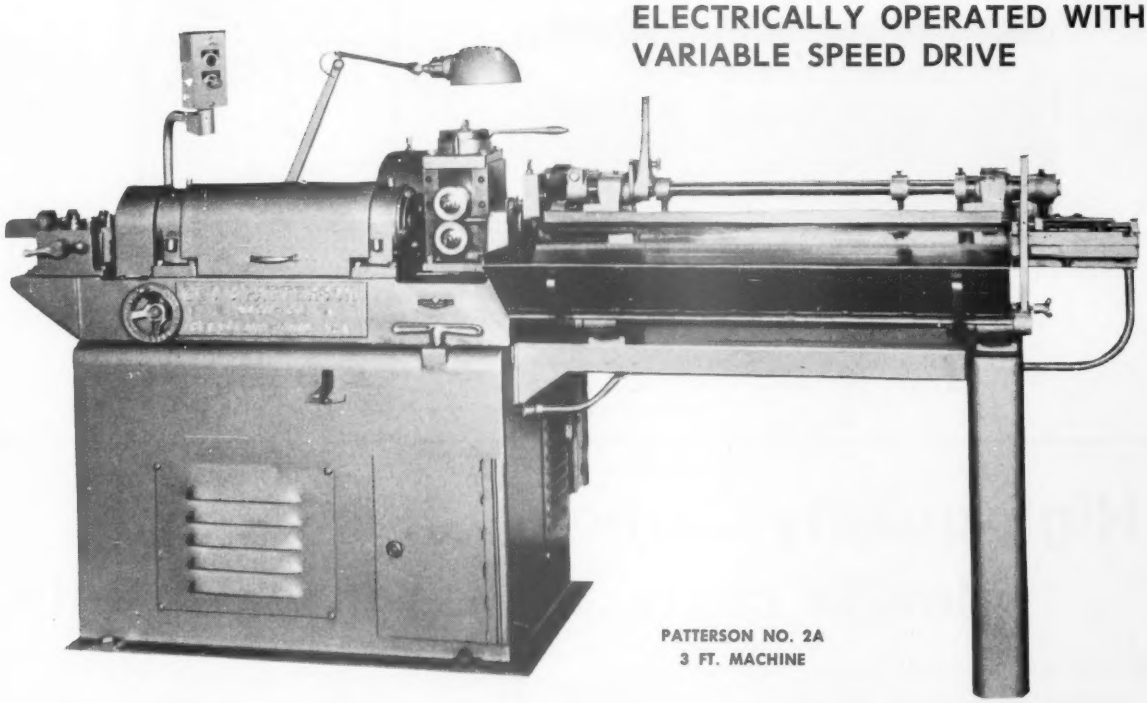
Open Hearth grades from C 1005—1095
Low Metalloid
Thomas (Basic Bessemer) grades
Sizes from .200" —½"
Coils from 180—880 lbs.
Inside diameters 20, 24, 26, 33½"
Unitized bundles of 3000 lbs. are now our standard shipping package
Reliable delivery schedules at a fair price

KURT ORBAN
COMPANY, INC.

34 A Exchange Place. Jersey City 2, N. J.
In Canada: Kurt Orban Canada. Ltd.,
Toronto & Vancouver

GEO. C. PATTERSON
HI-SPEED
AUTOMATIC WIRE STRAIGHTENING & CUT-OFF MACHINES

ELECTRICALLY OPERATED WITH VARIABLE SPEED DRIVE



PATTERSON NO. 2A
3 FT. MACHINE

This advertisement is directed to the overwhelming majority of those who actually are not familiar with the advantages of a PATTERSON Wire Straightening and selective length Cut-Off Machine, the many who have been thinking of its advantages, and to the few who actually know the advantages.

We can supply straightening and cut-off machines for ferrous or non-ferrous coiled material from .015 thru 1" diameter or equivalent area in shapes, from which you can straighten and cut bar stock, machine or automotive components, refrigerator, cupboard or dishwasher shelving, baskets, fan and stove guards—in fact, most anything that can be fabricated from wire, including re-enforcing bars.

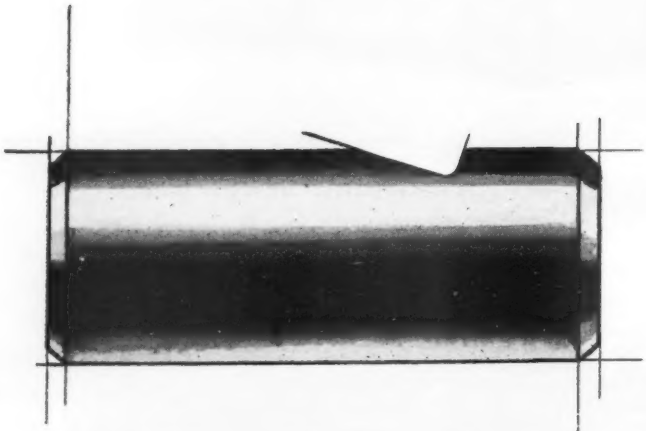
- **MINIMUM COST**
- **MAXIMUM PRODUCTION**
- **ACCURATE LENGTHS**
- **NEW FEATURES**

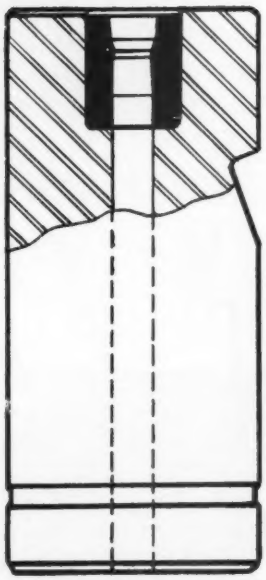
WRITE FOR FREE LITERATURE ON YOUR REQUIREMENTS

The GEO. C. PATTERSON Machine Company

3409 TRUMBULL ST. CLEVELAND 15, OHIO
PHONE: BRoadway 1-1808

"MOVING METAL" with Carboloy® Cemented Carbides



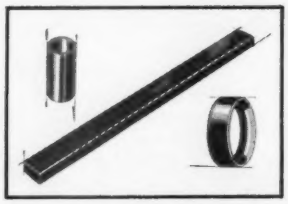


Top quality and performance in boltmaking machinery depend on header extrusion dies equipped with Carboloy cemented carbides —to produce more uniform parts to closer tolerances; resist stress and strain of heading and extruding operation.

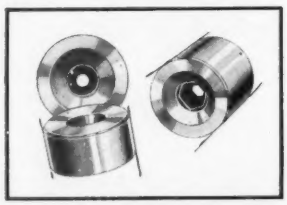
High-quality Carboloy dies mean lower costs . . . less metal waste

How efficiently you *"move metal"* from one shape to another depends on the quality, accuracy and uniformity of the carbide you use. General Electric Carboloy carbides for wire, bar, and tube-forming dies are designed to do the job better at lower cost, and with less metal waste.

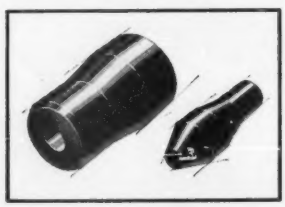
Continuing research by General Electric's experienced metallurgists and technicians results in carbides of highest quality and uniformity—dependability for the job at hand. Call your Carboloy Die Distributor or Die Maker to help you *"move metal"* at lower cost. Or write: *Metallurgical Products Department of General Electric Company, 11171 E. 8 Mile Ave., Detroit 32, Michigan.*



Boost wire production schedules by wear-proofing critical parts with G-E carbide wire guide bushings, strips, and guide rings on wire stranding and processing machinery. Last up to 100 times longer in some cases than those of other materials!



Get more wire tonnage with uniform size and finish. Carboloy carbide wire bar and tube dies boost product output, permit longer runs with less die wear, minimize downtime. Available in round, square, hexagon shapes.



Tube drawing with Carboloy mandrels provides uniform wall thickness. Tailored to your order, G-E mandrels come in brazed and solid carbide styles. Brazed-type custom-made from standard and special Carboloy nibs. Available from your Authorized Die Distributor or Die Maker.

CARBOLOY®
CEMENTED CARBIDES

METALLURGICAL PRODUCTS DEPARTMENT
GENERAL ELECTRIC

CARBOLOY® CEMENTED CARBIDES • MAN-MADE DIAMOND • MAGNETIC MATERIALS • THERMISTORS • THYRITE® • VACUUM-MELTED ALLOYS

Quality plus economy when you buy SUMITOMO steel wire rods

Rapid developments in the wire-product field have increased industry's demand for top-quality steel wire rods. Because of its international reputation for reliability, Sumitomo Metal supplies world markets — America in particular — with 7,000 tons of wire rods every month. To keep up with this export demand, Sumitomo Metal has added to its present facilities another new wire rod mill, completely equipped with the most modern machinery available.

Dimensions of Sumitomo Wire Rods

Diameter 5mm. (13/64″) — 16mm. (5/8″)

Weight Single Bundle
about 270 kgs. — 320 kgs.
600 lbs. — 700 lbs.
Compressed Bundle (6 coils)
about 1,620 kgs. — 1,920 kgs.
3,600 lbs. — 4,200 lbs.

Coil Dimensions on Request

LEADING PRODUCERS OF STEEL WIRE RODS, PIPE AND ROLLING STOCK PARTS

SUMITOMO METAL INDUSTRIES, LTD.

Head Office: Osaka, Japan
Cable Address: "SUMITOMOMETAL OSAKA"

New York Office: 420 Lexington Ave., New York 17, N.Y.
Cable Address: "SUMITMETAL NEWYORK"

MODERNIZE YOUR PREHEATING PROCESS WITH A

WALCO All Electric WIRE PREHEATER

Patent #2931891
and other patents pending

Now 3 MODELS

For copper or aluminum wire sizes #24 to #0, depending upon temperature and speeds required.

- Continuous wire pre-heating
- Uniform heat • Compact
- Portable • Easy to install
- Increases Production
- Temperature control
- Indicating Gauge
- Positive heat control at any given speed
- Non-Oxidizing • Infinite heat range with Safety of operation
- Synchronizes with other equipment. No spoilage
- Inexpensive to operate
- No fire hazard
- Minimum maintenance
- Rotating parts equipped with heavy duty ball bearings
- Eliminates temperature guess work
- Eliminates constant flame vigilance
- Eliminates hazardous gas lines
- Adjustable to line up with all make and size extruder heads
- Automatic "On" and "Off" operation

MODELS: W-7½ • W-15 • W-22

220/440/550 Volt, 1 Phase, 60 Cycle

Modifications & Accessories

A) Voltmeter, Ammeter & Pilot Light Panel
B) Front Enclosure Over Wheels
C) 50 Cycle
D) Multigroove Wheels
E) 3 Energized Wheels (in lieu of 2 standard wheels)
F) Automatic Temperature Control
G) Saturable Core Reactor Type Transformer

Whether you preheat before extruding, or anneal before drawing, or preheat before coating, contact us.

Telephone: PLantations 1-5400

WALCO ELECTRIC COMPANY
131 Blackstone St., Providence, R. I.

NEW EFFICIENCY for straight length spiral wrapping

Ludlow's new UW-10 Rod Wrapper is the most modern equipment made for the purpose . . . designed to do the job with never-before-achieved speed, neatness and dispatch.

Wraps straight lengths with smooth-as-silk precision, using a synchronized conveyor system and advanced-type electrical controls. Independent forward and reverse controls with conveyor motor permit rod handling when shuttle is stopped. Adjustable motor pulley, variable shuttle speed. Automatic electric shuttle brake for quick stop.

Sturdily constructed to stand the gaff of steady day in, day out operation.

Write for complete specifications describing nature and dimensions of product you wish to wrap.

The UW-10 Rod Wrapper joins a complete line of Ludlow spiral wrapping equipment. Spiral wrapping machines now range to accept roll widths from 4" to 16" . . . Accessories include a variety of special devices and papers as indicated below:

1. DEVICES for folding, edging and tension control.

2. CREPED WRAP includes regular and waxed kraft, asphalt and non-staining laminated, reinforced, VPI and non-asphaltic neutral (for anti-rust), and polyethylene coated or laminated.

3. PRINTED with your name or trademark in one or more colors if desired.

4. FIELD and TECHNICAL SERVICE available from Ludlow specialist engineers on all types of spiral wrapping equipment.

Ludlow

LUDLOW PAPER
A Division of Ludlow Corporation
Needham Heights 94, Mass.

Ludlow also furnishes a high quality line of treated and untreated jute electric yarn and roving for the wire and cable industry.

ARBOGA

THE BEELINE

Founded in 1856, AB Arboga Mekaniska Verstad — since 1943 a subsidiary of Morgardshammar — has for more than 60 years been designing and building wire drawing machines with Swedish precision and craftsmanship to keep pace with the increasing demands for higher production and trouble-free operation.

ARBOGA

Cable:
Telepho

WIRE DRAWING MACHINES

WORLD WIDE

PRECISION WITH RUGGEDNESS

This BEELINE DG-5 — designed for manufacturing wire used in pre-stressed concrete fabrication — is a heavy-duty, straight-line, non-slip wire drawing machine that delivers high speed production with minimum maintenance.

It is delivered as a complete machine, job-tested and ready to go into operation with a minimum of labor and installation expense. Complete engineering and service facilities are readily available.

Write
for your copy.

AB ARBOGA MEK. VERSTAD
ARBOGA, SWEDEN
Cable: VERKSTADEN, ARBOGA
Telephone: 0589/12720

Subsidiary of
MH MORGÅRDSHAMMAR

U.S. OFFICE **MH. MACHINES**
19002 LOMOND BLVD.
CLEVELAND 22, OHIO
TELEPHONE:
WYoming 1-5830

LOW COST precision wire plating

UNIFORM COATINGS MAINTAINED AT HIGH SPEEDS

CONTINUOUS
ELECTROPLATING
EQUIPMENT

This low cost equipment performs with such ease and efficiency that it means real savings for you. Preset quality control insures perfection without depending on operators' skill. No toxic fumes, clean operation at low temperature, elimination of work hardening during processing, and many other features are the result of experience and sound engineering that go into the design of all Universal equipment.

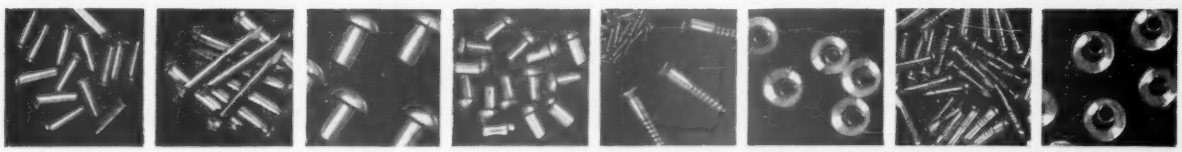
We furnish complete installation . . .
For further information write to:

UNIVERSAL INDUSTRIAL EQUIPMENT CO.
SECAUCUS, NEW JERSEY

U. S. PATENT NO. 2823180 AND FOREIGN PATENTS PENDING

Titan brass wire

will do any forming job better



This wire is the best for formability. It is brass wire. It is ductile, strong, uniform, sound.

It is responsive to your needs in forming nuts, rivets, bolts, fasteners, screws, nails, eyelets, studs, posts, terminals, washers, pins, cages, novelties, tacks, brads, wire cloth, springs, clips, cables, and a host of other products.

Titan wire is hot-extruded, annealed and drawn to achieve highest quality. You will find it free of defects.

It comes in a wide range of tempers and compositions to meet your requirements.

If you head and extrude, head and drill, or form and bend, we invite you to learn more about Titan Brass Wire. Call your nearest Titan Man.

Write for Brass Wire folder giving grain sizes, weights, tolerances

Established 1915

TITAN® METAL MANUFACTURING COMPANY

DIVISION OF **CERRO CORPORATION**

Bellefonte, Pa. • Newark, Calif. • Offices & Agencies in Principal Cities

RODS • FORGINGS • DIE CASTINGS • WELDING RODS • WIRE

NOW AVAILABLE IN CANADA

NORTHAMPTON MACHINERY PRODUCTS

FOR CABLE MAKING INDUSTRY

AT

CANADIAN VICKERS MONTREAL

EXTRUDERS
Plastic
Rubber

BUNCHING MACHINES

STRANDING MACHINES
Planetary
Tubular

LAYING-UP MACHINES

TWINNING MACHINES

QUADDING MACHINES

PAPER LAPPING MACHINES

COPPER INSULATING MACHINES

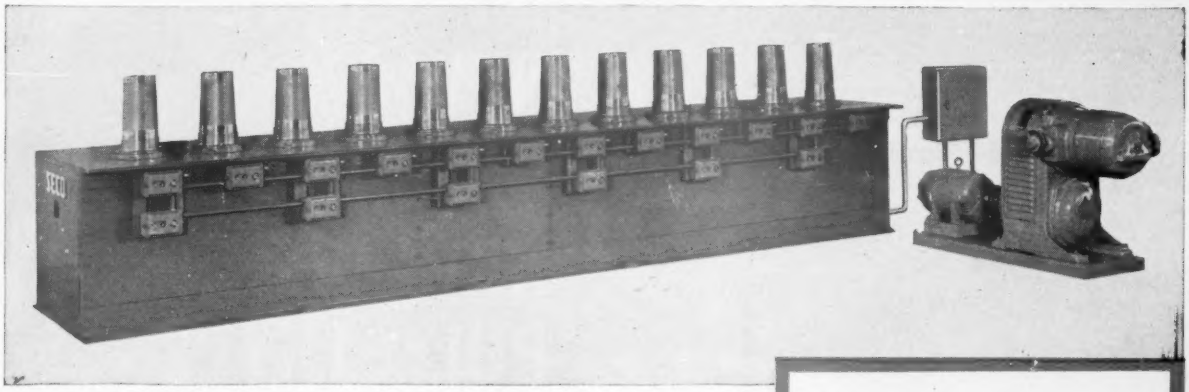
AUXILIARY EQUIPMENT
Supply Stands
Wire Accumulators
Take-Up Stands
Capstan and Caterpillar Haul-off units
Extruder Lines Complete With Cooling,
Measuring and Quality Control Apparatus
Special Purpose Cable
Making Machinery to Customers' Specific
requirements

FOR FURTHER INFORMATION

CANADIAN VICKERS LIMITED
P.O. Box 550 — Place d'Armes Station
MONTREAL
CANADIAN MEMBER OF THE VICKERS GROUP

SECO Fine wire TAKE-UP FRAMES

The "last-word" in wire-winding efficiency!



- **Simplified Design and Construction**
- **Synchronized Electrical Variable Speed**
- **Noiseless, Vibrationless Running**
- **Greatly Increased Operating Capacity**

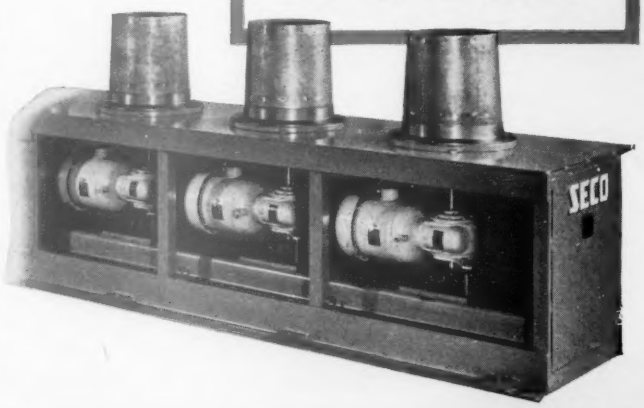
SHOWN ABOVE:
SECO Take-Up Frame and VARIDYNE Electrical Power Unit which provides synchronized variable speed to the multiple drives. AC current is employed throughout, and the VARIDYNE System "gears" all the drives together by electrical impulses.

SHOWN BELOW:
The AC squirrel-cage induction type gear motors which drive the spindle blocks through hollow bored shafts.

SECO builds take-up frames for handling fine gauge steel or non-ferrous wire on 8", 12", or 16" diameter blocks...with linear wire speeds up to 1,000 FPM or higher. Superior features include a multiple electrical drive system (alternating current) for synchronized electrical transmission of variable speed power.

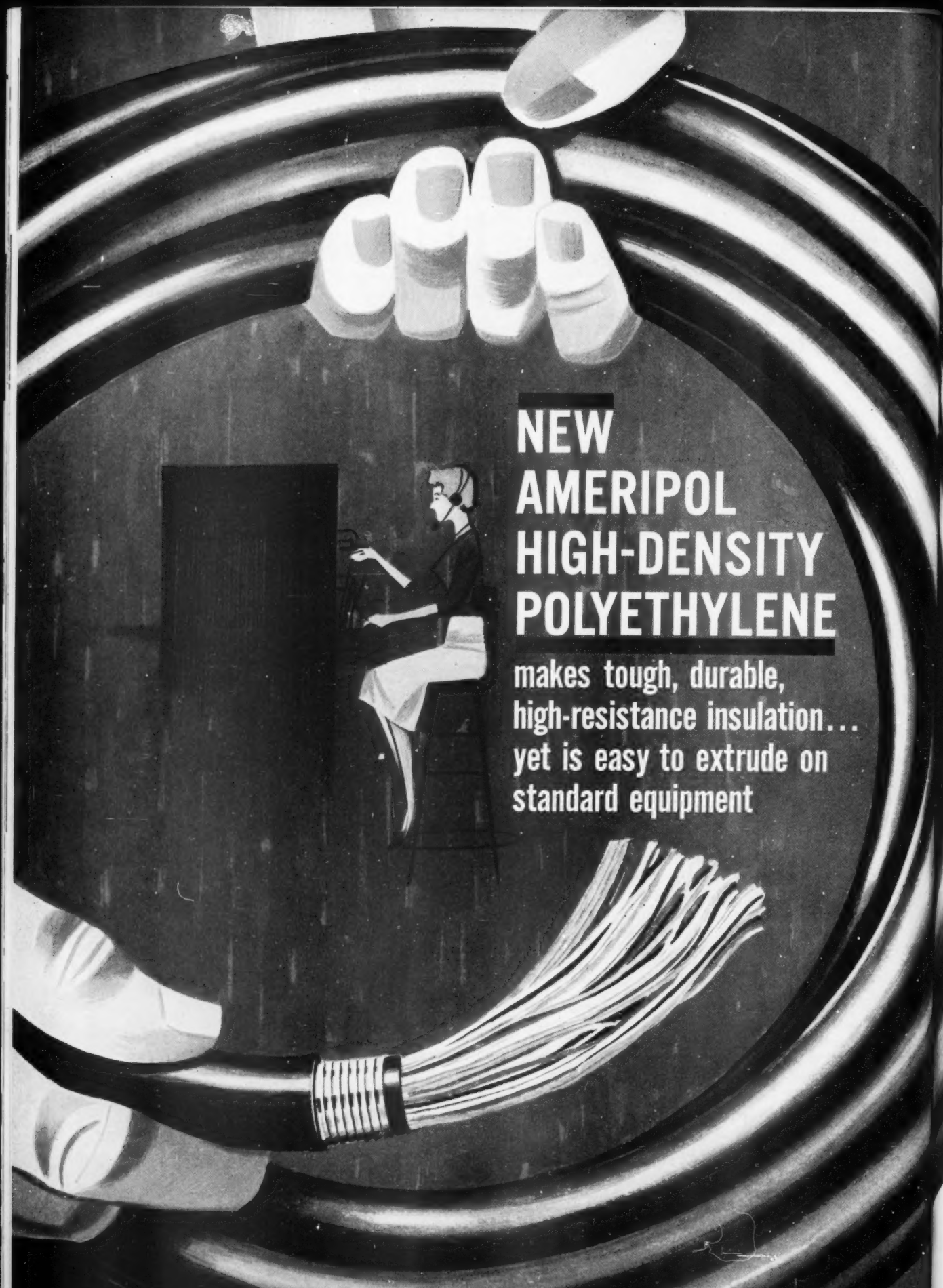
This gives simultaneous speed changes to all spindle blocks, in ratios up to 5:1 or even 10:1 or higher. It provides push-button stop-start control to each of the gear motors driving each spindle block. Gone is the old bevel gearing, with manually operated clutches for starting and stopping the blocks.

SECO high production take-up frames are constructed to accommodate any number of spindles required. Frames with horizontal spindles can also be built. Call or write for complete information and data. Consultation invited—no obligation.



STEEL EQUIPMENT COMPANY
P. O. BOX 737, WARRENSVILLE STATION
CLEVELAND 22, OHIO

SECO


NEW
AMERIPOL
HIGH-DENSITY
POLYETHYLENE
makes tough, durable,
high-resistance insulation...
yet is easy to extrude on
standard equipment

Ameripol polyethylene for wire and cable. Ameripol polyethylene is a **new** ethylene plastic polymer that combines durability and processability.

The Goodrich-Gulf process imparts new highs in the important properties of environmental stress cracking resistance (SCR) and thermal embrittlement resistance, while maintaining the processing ease of conventional high-density polyethylenes.

This material makes an exceptionally tough, cut-resistant, abrasion-resistant coating for wire and cable. The insulation has excellent dielectric properties and resistance to elevated temperatures.

Ameripol can be extruded on standard equipment at commercial production rates. Thus high-density polyethylene is now practical for wire and cable fabrications.

Write for Ameripol Data File—contains complete information on properties, specifications, application to wire and cable.

PROPERTY	UNITS	ASTM METHOD	AMERIPOL 34	AMERIPOL 35
Dielectric Strength @25°C (a)	volt/mil	D149-59	1100	1100
Dielectric Constant @25°C...		D150-59T		
60 cps.			2.16	2.16
1,000 cps.			2.19	2.19
10,000 cps.			2.26	2.26
100,000 cps.			2.31	2.31
1.0 mc.			2.38	2.38
Dissipation Factor @25°C....		D150-59T		
60 cps.			0.0002	0.0002
1,000 cps.			0.0002	0.0002
10,000 cps.			0.0002	0.0002
100,000 cps.			0.0003	0.0003
1.0 mc.			0.0003	0.0003
Volume Resistivity.....	ohm-cm	D257-58	7×10^{15}	7×10^{15}
Insulation Resistance (b)....	megohms/ 1000 ft.	D257-58	167,000	265,000
Low Temperature Wire Wrap (c).....		D1351-54T	Passed	Passed

(a) #14 wire with a total wire and wall thickness of 0.128 inches, immersed in tap water 1 hr. @ room temperature before testing.
(b) Tested on #20 wire with a 64-mil wire and wall thickness for 1 year at 75°C.
(c) #20 insulated wire wrapped 8 times on a 0.313" mandrel at −70°F.

CHECK THESE SUPERIOR ELECTRICAL PROPERTIES

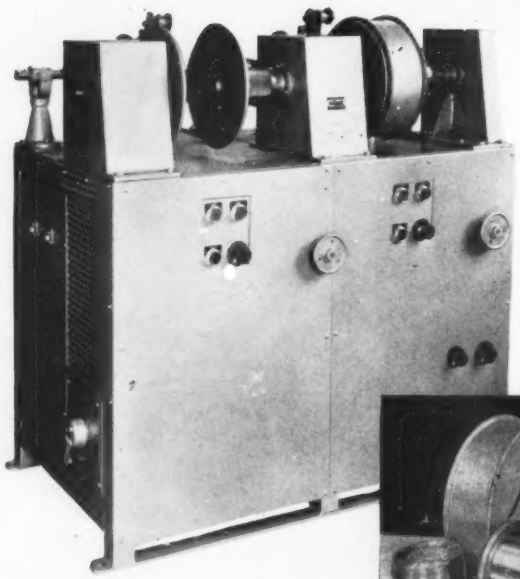
Goodrich-Gulf Chemicals, Inc.

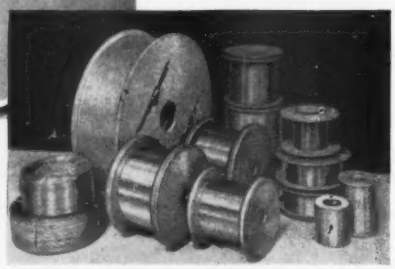
1717 East Ninth Street • Cleveland 14, Ohio

THE ONE TO WATCH FOR NEW DEVELOPMENTS

LATEST

AUTOMATED MULTI-SPINDLE ROBERT J. EMORY SPOOLER





ADVANCED DESIGN ● HIGHEST PRODUCTION ● ACCURATE WINDING ● WIDEST RANGE ● FULLY ADJUSTABLE ● ONE MAN OPERATION ● PRODUCTION PROVEN ● MODERATE PRICE

MODEL 400 B Two to Ten Heads. Integral Payoff. Non-removable arbors. 3000 RPM Speed. Automatic Stops. No vibration.

EMORY NO. 700 TRAVERSE

Minimum number of wear parts. Two precision cut buttress thread screws are engaged alternately by bronze half nuts, giving absolutely positive, pin-point reversal. The "Trigger Action" reversing mechanism can be adjusted from 1½" minimum travel to maximum without stopping the spooler.

EMORY NO. 901 TINNING SPOOLER

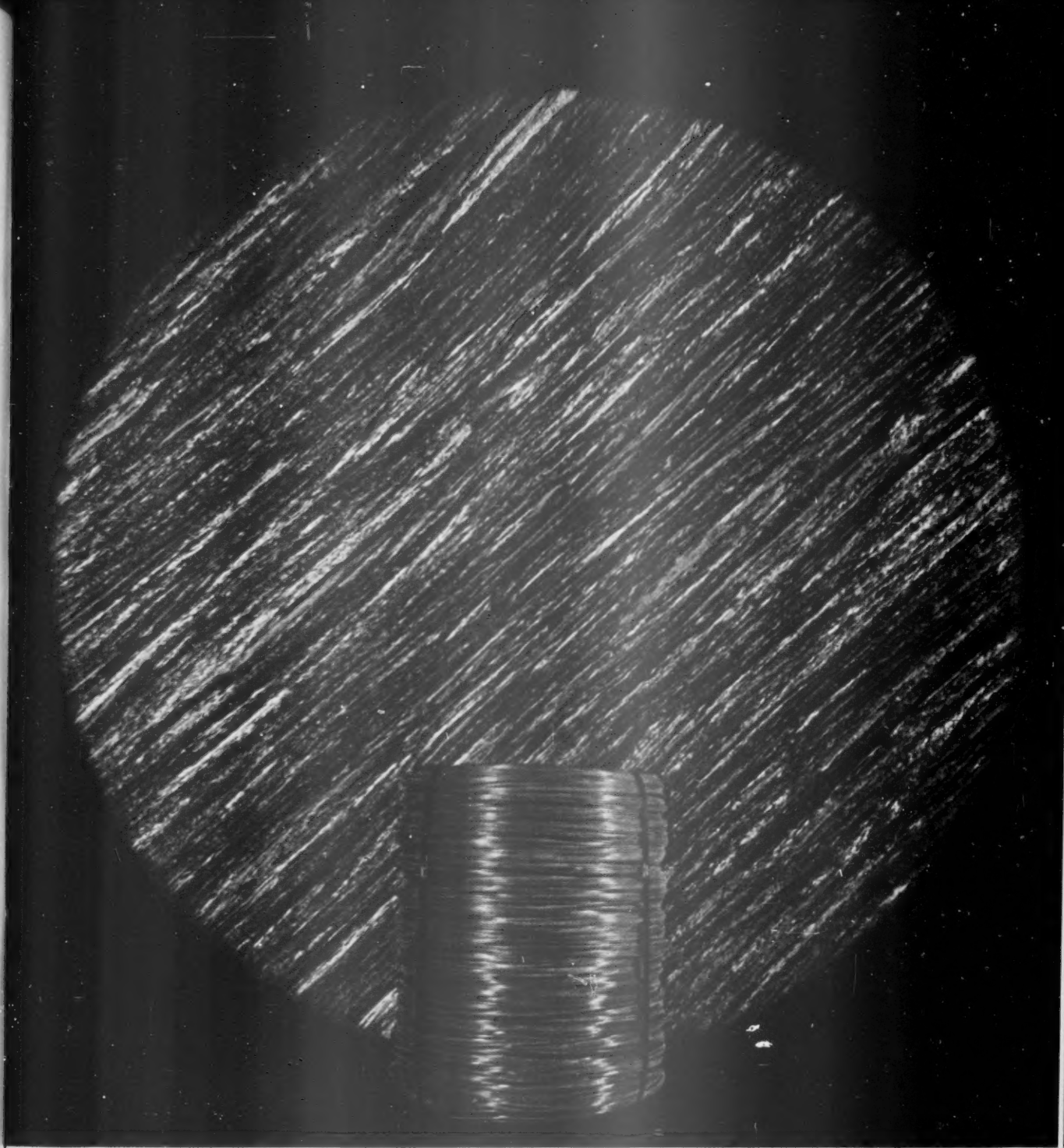
This 24-spindle spooler handles wire from .003" to .080" in diam. Each spindle is operated as an independent member. Can be built to handle customer's spool size.

DETAILED FEATURES

1. Electrically controlled, run, stop, jog, speed
2. Individual drives for each spindle by motor or magnetic clutch
3. Variable speed spindles and traverse 18 to 1 ratio
4. Wire range One to 200 mils diameter
5. Fast spool and reel changes in seconds
6. Winds spools or tied cores
7. One to 200 lb. capacity
8. Automatic stops on each spindle for full spool or wire fracture
9. Controlled and calibrated tension
10. Uniform thread winding
11. Large capacity reels positioned on inclined bearings close to floor to eliminate lifting
12. Power drawn synchronized payoff
13. Constant linear speed of annealing and tinning operations
14. Electrically controlled drags and brakes synchronized with winding spindle
15. Available for braider — bobbin winding of multiple end strands at highest winding speeds, simplest operation
16. Special construction for winding magnet wire on disposable plastic or masonite spools

ROBERT J. EMORY COMPANY
31 East Runyon Street Newark 8, N. J.

60 YEARS OF WIRE MACHINERY EXPERIENCE



Photomicrograph of Springkote Wire Mag. 500 x

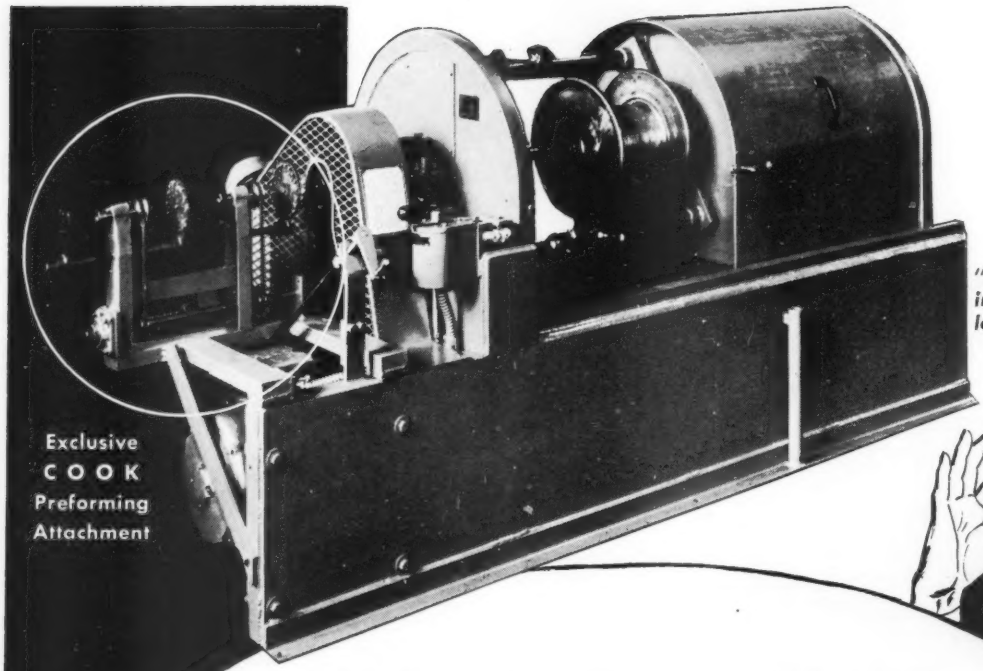
Take a close look at Roebling Springkote* Wire

To the metallurgist's eye the grain structure revealed in this photomicrograph is a picture of high carbon wire, cold drawn from a uniformly patented condition, resulting in uniformly high tensile and long-life resiliency. It is one reason why so many upholstery spring makers prefer Springkote Wire. But it is only one reason. Springkote offers other advantages that cannot be seen until you *use* it. For example, Springkote solves stress-relieving problems, puts an end to burned-out electrical contacts and uneven heat distribution. It runs more smoothly through coiling and knotting machines and paints better. It is available in bundles up to 3000 pounds. All of which means longer runs at less cost. That's why we say, take a *close* look at Springkote Wire. For the details write to Roebling's Wire and Cold Rolled Products Division, Trenton 2, New Jersey.

*Reg. T. M.

ROEBLING

Branch Offices in Principal Cities
John A. Roebling's Sons Division
The Colorado Fuel and Iron Corp.



Exclusive COOK Preforming Attachment

"My job is to get maximum production at the lowest possible cost"

"I've checked plenty of bunching machines . . . but

only COOK bunchers can make perfectly concentric wire!"

All capacities from 45 lbs. to 1000 lbs. All reel sizes from 8" x 6" up to 30" x 11" based on solid copper wire

Now you can speed up production . . . cut the cost of insulating material and labor

The single twist design and large take-up reel are only two of the many outstanding features of COOK bunchers. The single twist principle insures perfectly round bunched wires* at high speed while the **large** take-up reel provides more practical wire packaging sizes for extra long extruder runs. Both these innovations reduce material waste and down time at the extruder.

For production of either concentric wire (with layers of wires in opposite directions of lay) or semi-concentric wire (with layers of wires in the same direction but with different lay to prevent strand locking) you simply can't beat a COOK buncher!

*Bunched wires so perfect that they can pass through an extruding die of only 1 mil clearance

MEET MILITARY SPECIFICATION: MIL-W-5086

Write for free **BUNCHER** catalog sheet

COOK MANUFACTURING CO. 50 East 25th Street, Paterson, N. J. — ARMORY 4-6380

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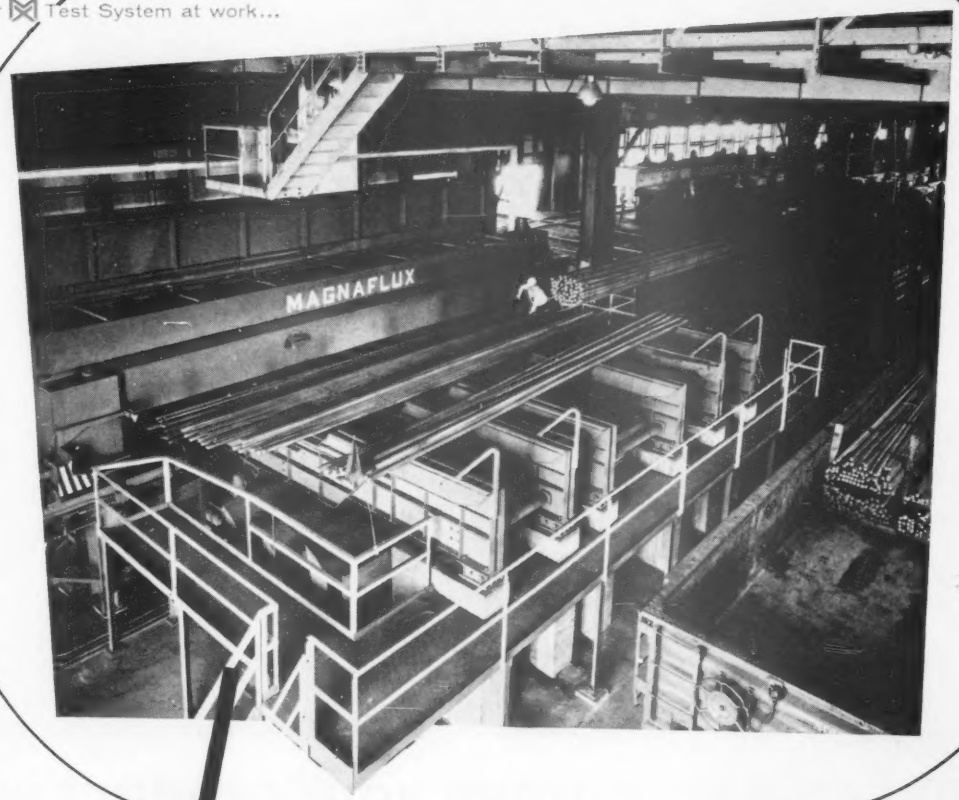
ASK FOR LITERATURE ON COOK'S HIGH SPEED CABLERS

Another MX Test System at work...



Another Magnaglo Billet Conditioning Installation

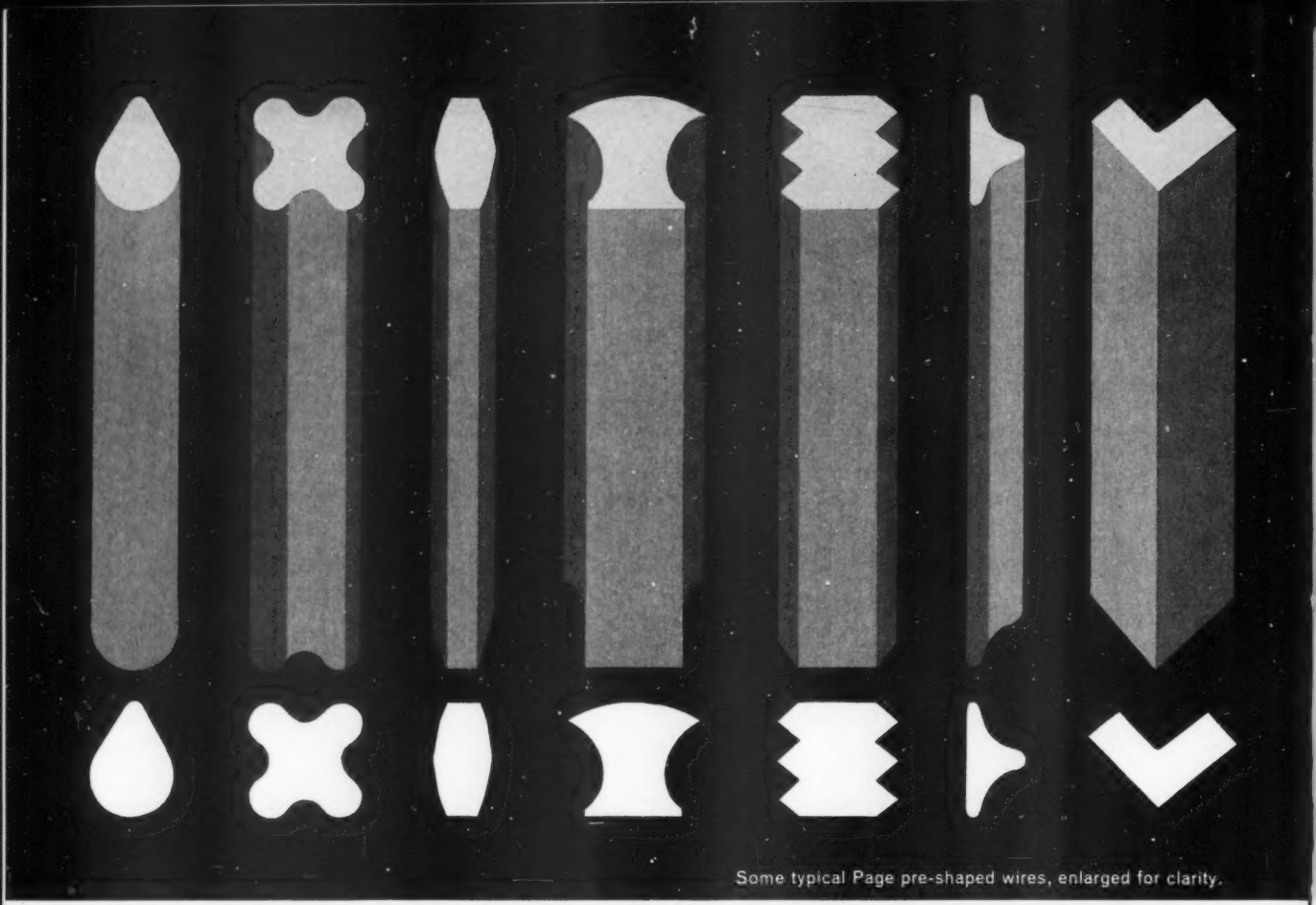
This complete Magnaglo system was designed and produced by Magnaflux Corporation. It is just one example of Magnaflux ability to engineer and fabricate complete automated handling and testing systems for the steel industry.

A well-integrated Magnaglo inspection and handling system gives you better, more complete, control of billet quality from conditioning. And you can control the Magnaglo sensitivity to identify only the seams you want to scarf. This makes possible increased mill yield, substantially reduced billet conditioning costs, and consistently higher quality in the semi-finished state.

More and more mills are taking advantage of the years of experience gained by Magnaflux, the pioneer developer of magnetic particle test-handling systems for billets, tube rounds, and welded or seamless tubing and pipe. Now, how can we help *you*? Phone your local MX Field Engineer or write to Magnaflux Corporation, 7346 West Lawrence Ave., Chicago 31, Illinois.

MAGNAFLUX CORPORATION
TEST SYSTEMS
A SUBSIDIARY OF GENERAL MILLS

MX Test Systems Include MAGNETIC PARTICLE, FLUORESCENT PENETRANT, THERMOGRAPHIC, EDDY CURRENT, ULTRASONIC, STRESS ANALYSIS, GAMMA RAY SERVICE, DYE PENETRANT & MAGNETIC FIELD



Some typical Page pre-shaped wires, enlarged for clarity.

Cut your costs, improve your product with PAGE *Pre-Shaped* WIRE!

PAGE *pre-shaped* wire simplifies product design, reduces material costs. It requires no machining, no forming, no forging. It's delivered to you in *any* shape you require—from the simplest standards to complex "specials" made from your own drawings. You can specify low carbon, high carbon, alloy or stainless steels, or ARMCO ingot iron. The PAGE mill is America's leading special-purpose wire producer, so your specifications regarding physical properties and size tolerances are no problem. What's more, you can order your PAGE *pre-shaped* wire shipped with the kind of packaging you want. Most important, you can *always* count on PAGE uniformity.

Send us a sample of the shaped wire you now use, or a description of your wire needs—prove to yourself how PAGE can help. Tell us your wire analysis and tonnage requirements. We'll recommend a PAGE *pre-shaped* wire to help reduce your costs, simplify your manufacturing and improve your product.

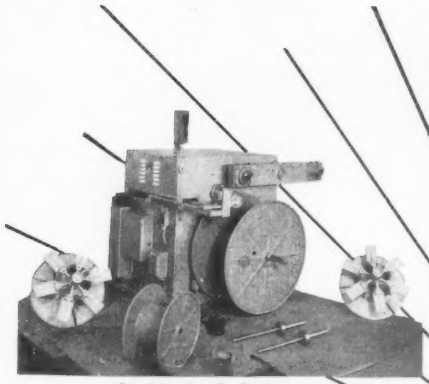
Write us at Monessen, Pa. for Booklet **DH-1226** on PAGE *pre-shaped* wire, or for information on what PAGE has to offer to meet your other wire requirements

PAGE *the source for answers to wire problems*

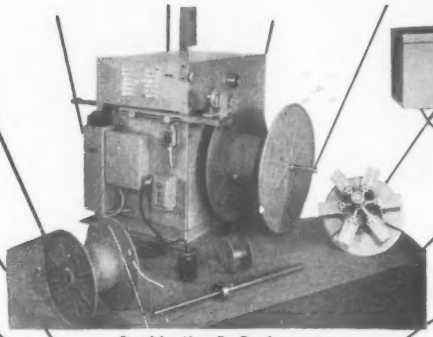
ACCO

PAGE STEEL AND WIRE DIVISION • AMERICAN CHAIN & CABLE COMPANY, INC.

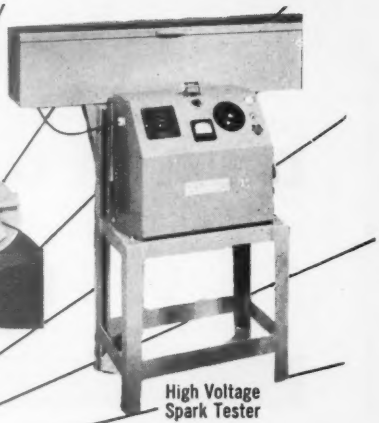
Monessen, Pa., Atlanta, Chicago, Denver, Detroit, Houston, Los Angeles, New York, Philadelphia, Portland, Ore., San Francisco, Bridgeport, Conn.



Combination Re-Reeler and
Re-Spooler with Indexing Head

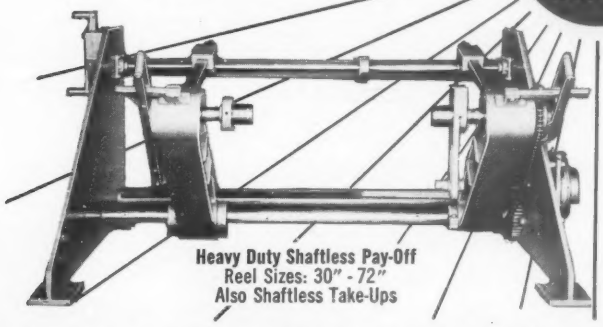


Combination Re-Reeler and
Re-Spooler with Interchangeable
Shaft Features

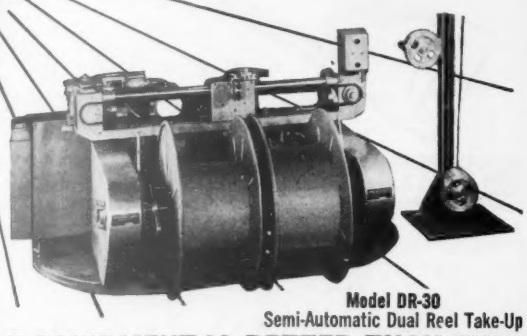


High Voltage
Spark Tester

FOR ACCURACY — DAVIS WIRE & CABLE EQUIPMENT — FOR DEPENDABILITY



Heavy Duty Shaftless Pay-Off
Reel Sizes: 30" - 72"
Also Shaftless Take-Ups



Model DR-30
Semi-Automatic Dual Reel Take-Up

THE NEWLY REDESIGNED *DAVIS WIRE & CABLE EQUIPMENT* IS BETTER THAN EVER

Modernized, streamlined and engineered for fast production of safely insulated wire and cable, the newly redesigned DAVIS ELECTRIC line of Spark Testers, Pay-Offs, Take-Ups, Counters, Spoolers, Traverses and Capstans is now offered as the finest ever conceived and produced by DAVIS ELECTRIC engineers. Before you buy, you owe it to your pocketbook as well as your business reputation to learn what this unexcelled machinery can do to better satisfy your customers (and your stockholders!). Refinements and advancement in designs qualify the 1961 DAVIS ELECTRIC line to surpass in performance previous DAVIS products in use in 80% of the industry's wire mills and some of which have been in operation for 15 years without maintenance problems!

What better tribute to quality can one ask?

Write for complete details and find out how DAVIS ELECTRIC can improve your wire and cable production and promote profit in your plant.

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DAVIS ELECTRIC CO.

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DUAL and SINGLE TAKE-UPS • PAY-OFFS • CAPSTANS
SPARK TESTERS • RE-SPOOLERS
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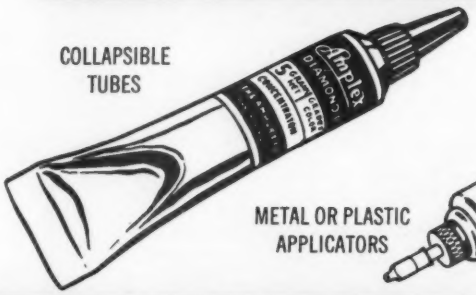
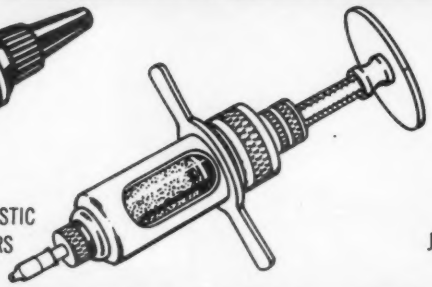
DIAMOND PRODUCTS for the WIRE INDUSTRY

AMPLEX Diamond Compound for Carbide and Diamond Dies

COLLAPSIBLE TUBES





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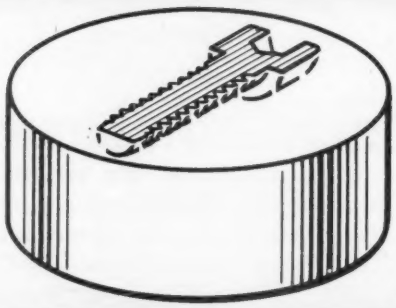
JARS

AMPLEX Diamond Hones for Blending Radii

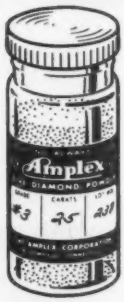
3/16", 1/4" diam. on 1/8" shank, 30° angle.

5" x 3/8" holder for hand operation.

AMPLEX Diamond Compound for the Metallurgist



AMPLEX Precision-graded Diamond Powders



Pure, virgin diamond crushed, processed and precision-graded in our own modern laboratory.

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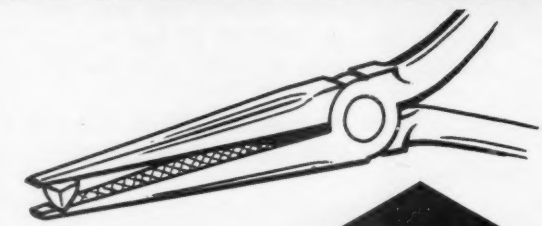

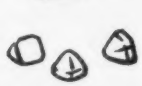

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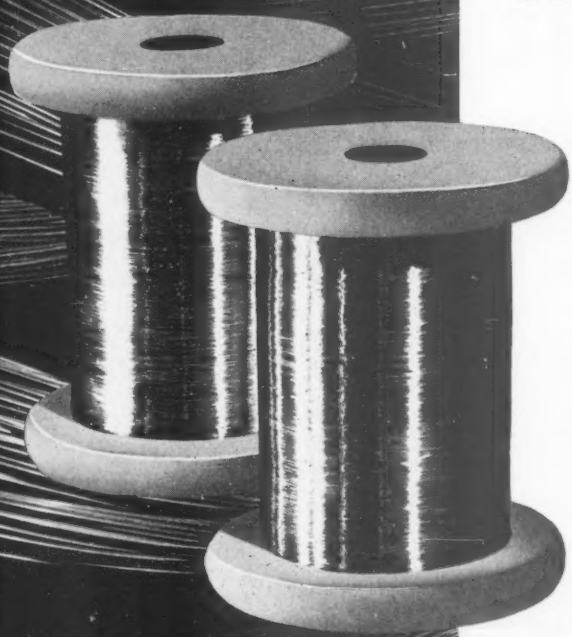

We can supply you — from our warehouses in Boston and Chicago — with a complete line of the highest quality wire. All wire is certified to be in complete conformity to A.I.S.I. specifications. Certified analyses and mechanical test reports are available. Metallurgical and Engineering service available to help you.

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The largest Producer of Fine Wire in the World
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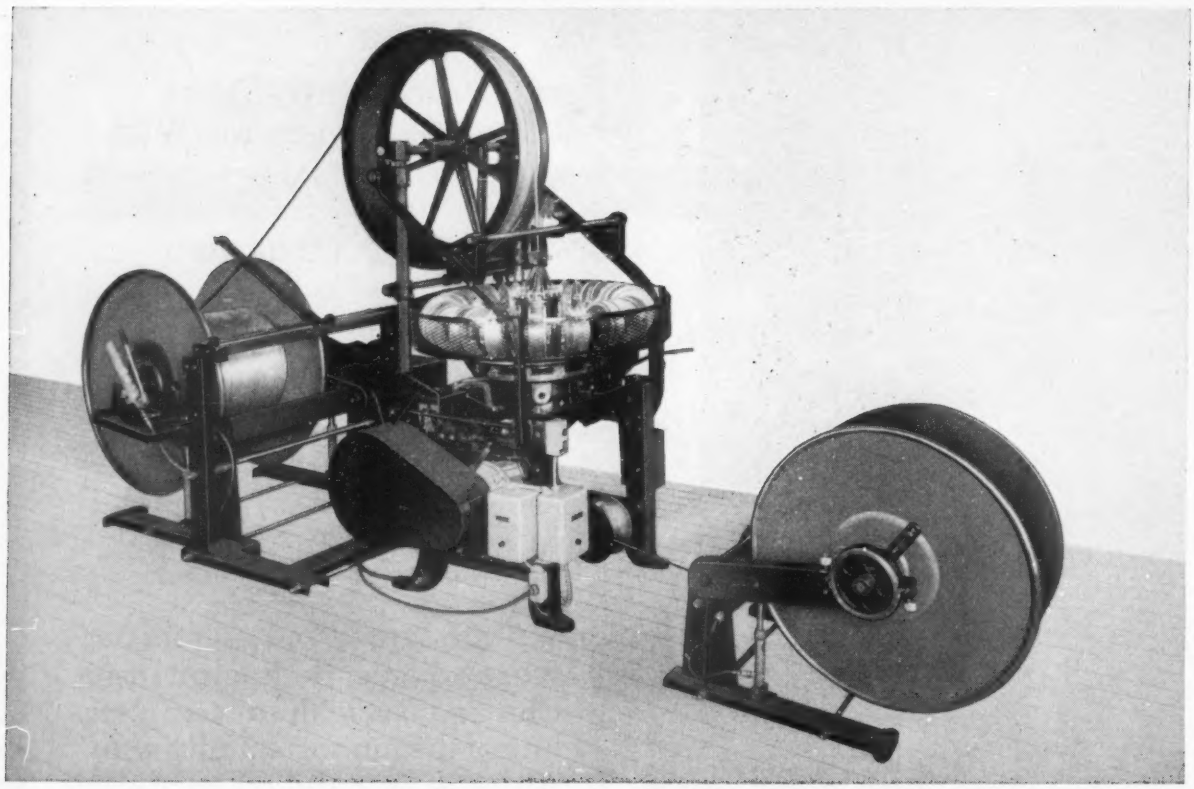
New Improved WARDWELLIAN®

MULTIPLE-END ARMOR WIRE SERVER

Applies multiple ends of wire to electrical conductors — for underground distribution cable and other applications



- For production of underground distribution cable, using multiple ends of flat wire, .009 x .047.
- Equipped with individual tensioning device for each supply package, thus assuring a uniform product.
- Electric stop-motion operates upon breakage or exhaustion of wire at each supply package.
- Machine will accommodate eighteen ten-pound packages of .009 x .047 wire, or other multiples when specified on order.
- Speed of head: 150 RPM.
- Capstan 36" diameter, 6" face.
- Machine driven by 2 HP motor, voltage as specified on order. Standard set of twelve change-gears furnished with each machine.
- New design pay off stand and windup stand as illustrated for accommodating reels from 30" to 48" in diameter. Maximum weight of full reel 5000 pounds.
- Reels raised and lowered hydraulically on both pay off stand and windup stands.
- Pay off stand equipped with adjustable friction-control for desired tension delivery.
- Windup stand equipped with adjustable traverse mechanism.
- Windup stand operated by individual motor through fluid-drive to insure constant rate of draft.
- Machine can be adapted for applying textile coverings with yarn, glass, and various types of synthetics. Copper wire and wires of similar nature can also be applied to other conductors.
- **Pay off stand and windup stand can be furnished separately or in pairs for use with other types of equipment.**

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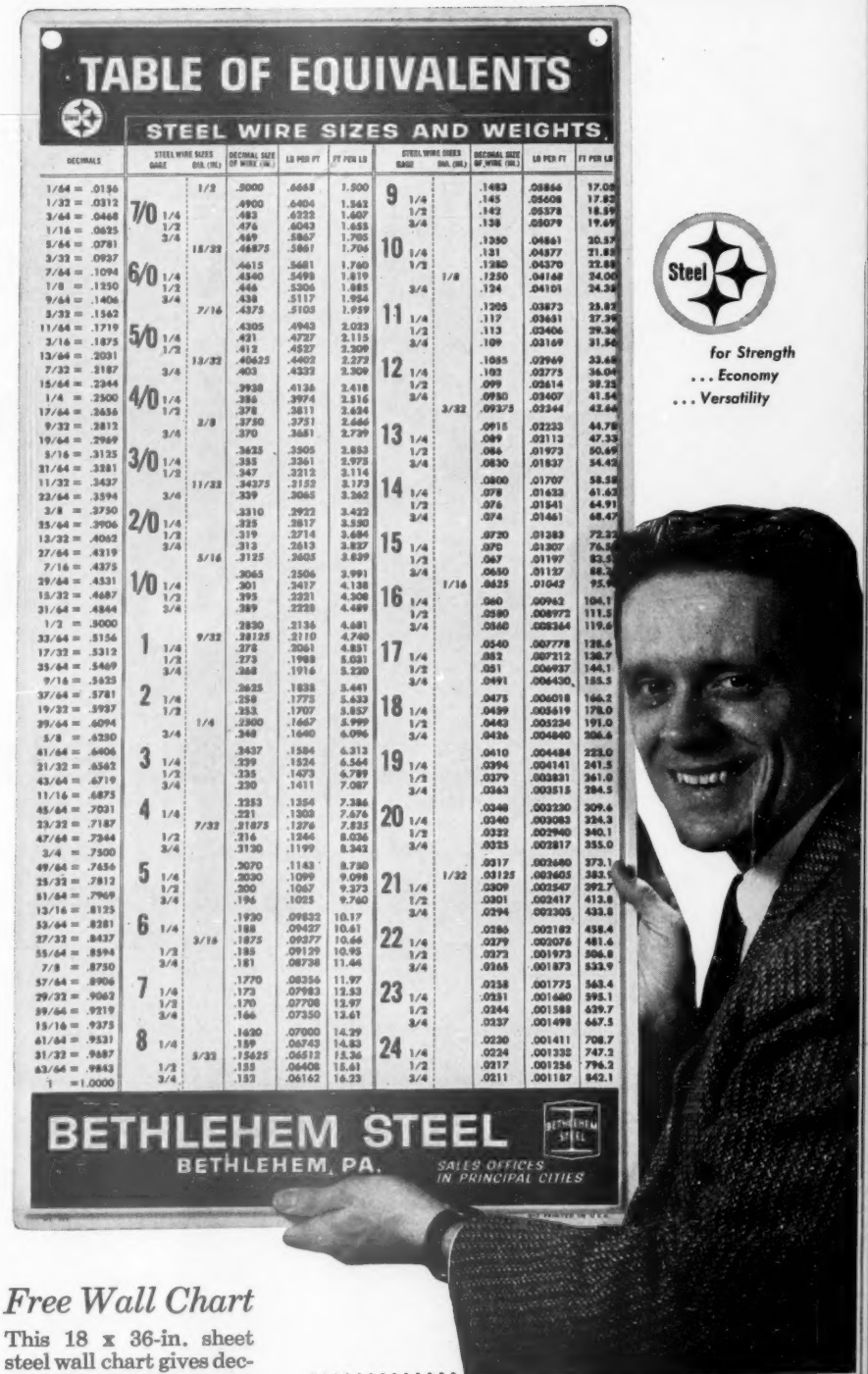
5. bethanized
6. bicycle spoke
7. border
8. bright basic
9. brush handle
10. cable lashing
11. chain link fence
12. clean bright
13. clothes pin
14. coat hanger
15. cold-heading
16. core (ACSR)
17. extra smooth clean bright
18. fence
19. foundry core
20. galvanized
21. hog ring
22. hose
23. link
24. mechanical spring
25. pail bail
26. rivet
27. rope
28. "scrapless nut"
29. screw
30. screwdriver
31. shaped
32. spoke
33. staple
34. strap
35. strand
36. telephone
37. tire chain
38. upholstery spring
39. welding
40. wool



Steel

for Strength ... Economy ... Versatility

Free Wall Chart

This 18 x 36-in. sheet steel wall chart gives decimal equivalents, wire sizes, and gages from 7/0 to 24¾, with corresponding decimal sizes, lb per ft, and ft per lb. For your free chart, just fill out and mail us the coupon.

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BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.,
Export Sales: Bethlehem Steel Export Corporation

PUBLICATIONS DEPARTMENT
BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

Dear Sirs:

Please send me information on type of wire circled.

1	6	11	16	21	26	31	36
2	7	12	17	22	27	32	37
3	8	13	18	23	28	33	38
4	9	14	19	24	29	34	39
5	10	15	20	25	30	35	40

and _____.

☐ *Please send "Table of Equivalents" wall chart.*

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Firm _____

Street _____

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of cables, strands and i

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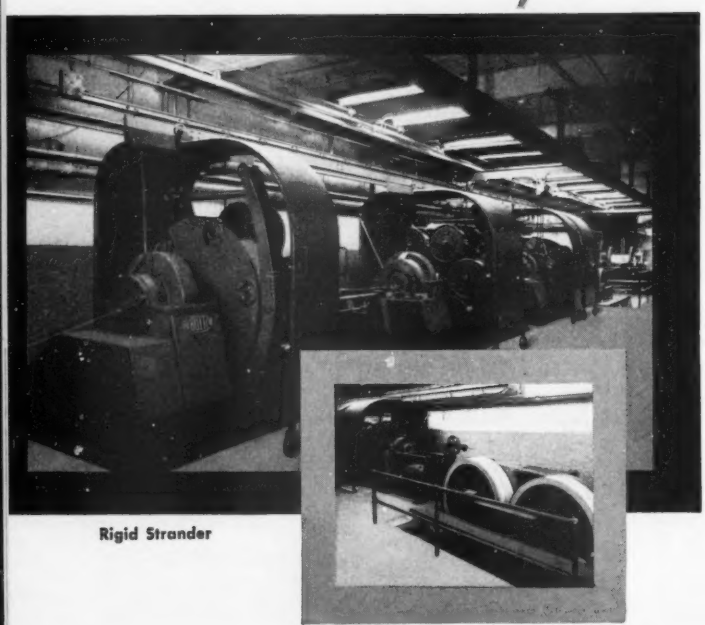
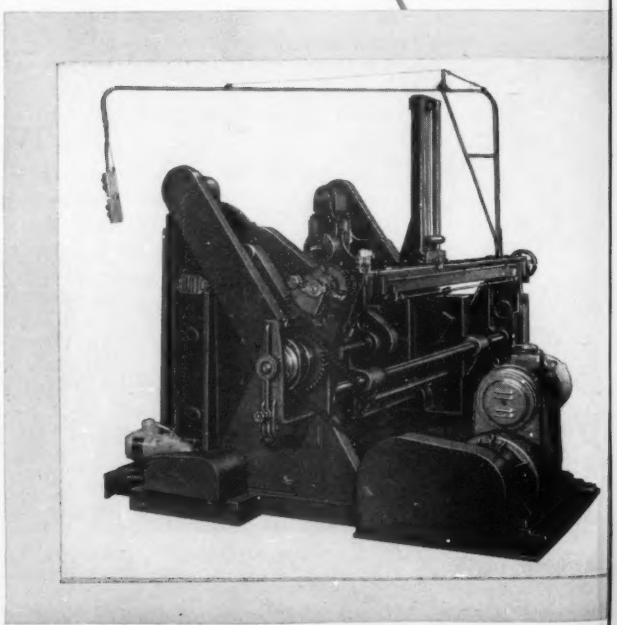
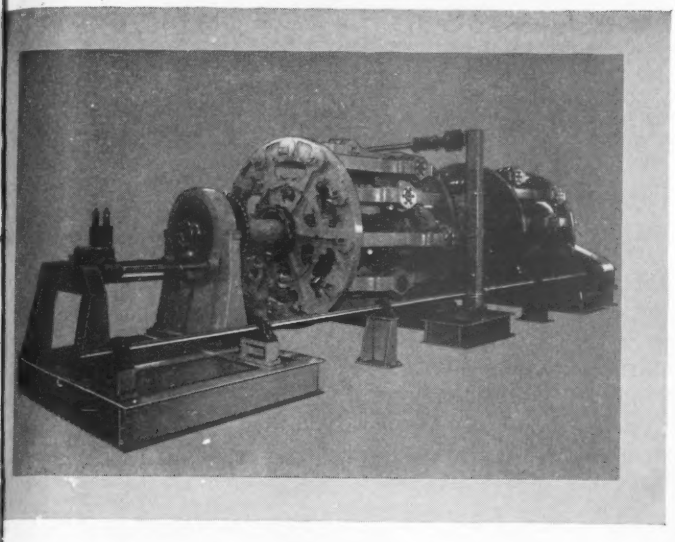


Rigid Strander

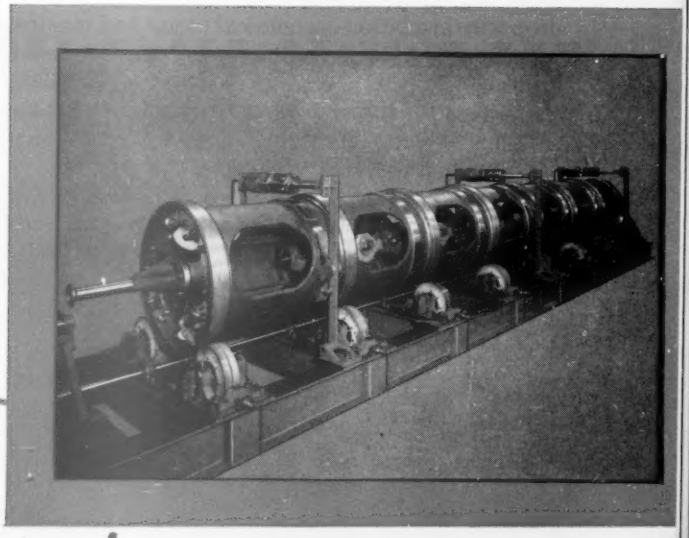


96" Shaftless Take-Up. Guard removed to show drive

24-Strand Planetary Cabler — 22" dia. Reels



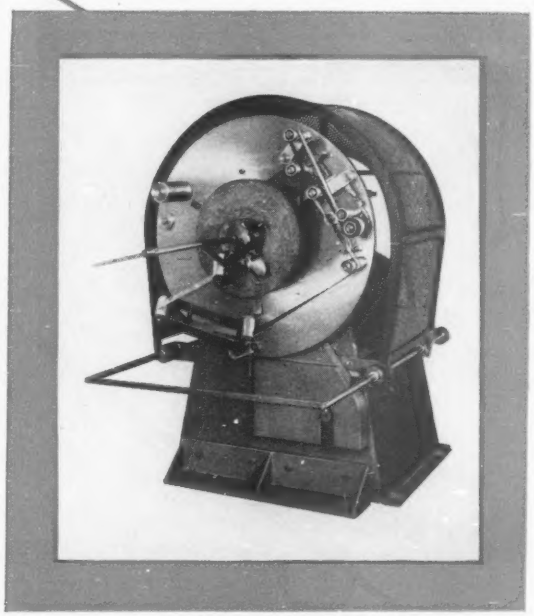
7-Wire Tube Strander



d production

d insulation

Eccentric Taping Head



Concentric Taping Head

New England Butt Co.

Division Wanskuck Company

304 Pearl Street · Providence 7, R. I.

In ENGLAND — James Day (Machinery) Ltd., Tudor Road, Wealdstone, Middlesex
Cable: Jasday, Harrow

BRAIDERS
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STRANDERS
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for the right number in line and drop wire insulation...

Monsanto Polyethylene compounds MPE 12 and MPE 11302 help make line and drop wire insulation economical to use and maintain because they impart superior weather-aging characteristics, good abrasion resistance, and resistance to fatigue, insuring long service life. MPE 12 and MPE 11302 contribute to excellent appearance—smooth surface, good gloss, and excellent carbon black dispersion.

Both offer fast extrusion rates. You can be sure of product uniformity because of Monsanto blend to blend uniformity. These resins impart good physical and electrical properties, meeting all applicable A.S.A. and IPCEA specifications.

Monsanto Polyethylene formulations are based on long experience in supplying the specialized needs of the Wire and Cable Industry. MPE 12 and MPE 11302 are but two in Monsanto's range of polyethylene resins developed for wire insulation. For more information, write to Monsanto Chemical Company, Plastics Division, Room 827, Springfield 2, Mass.

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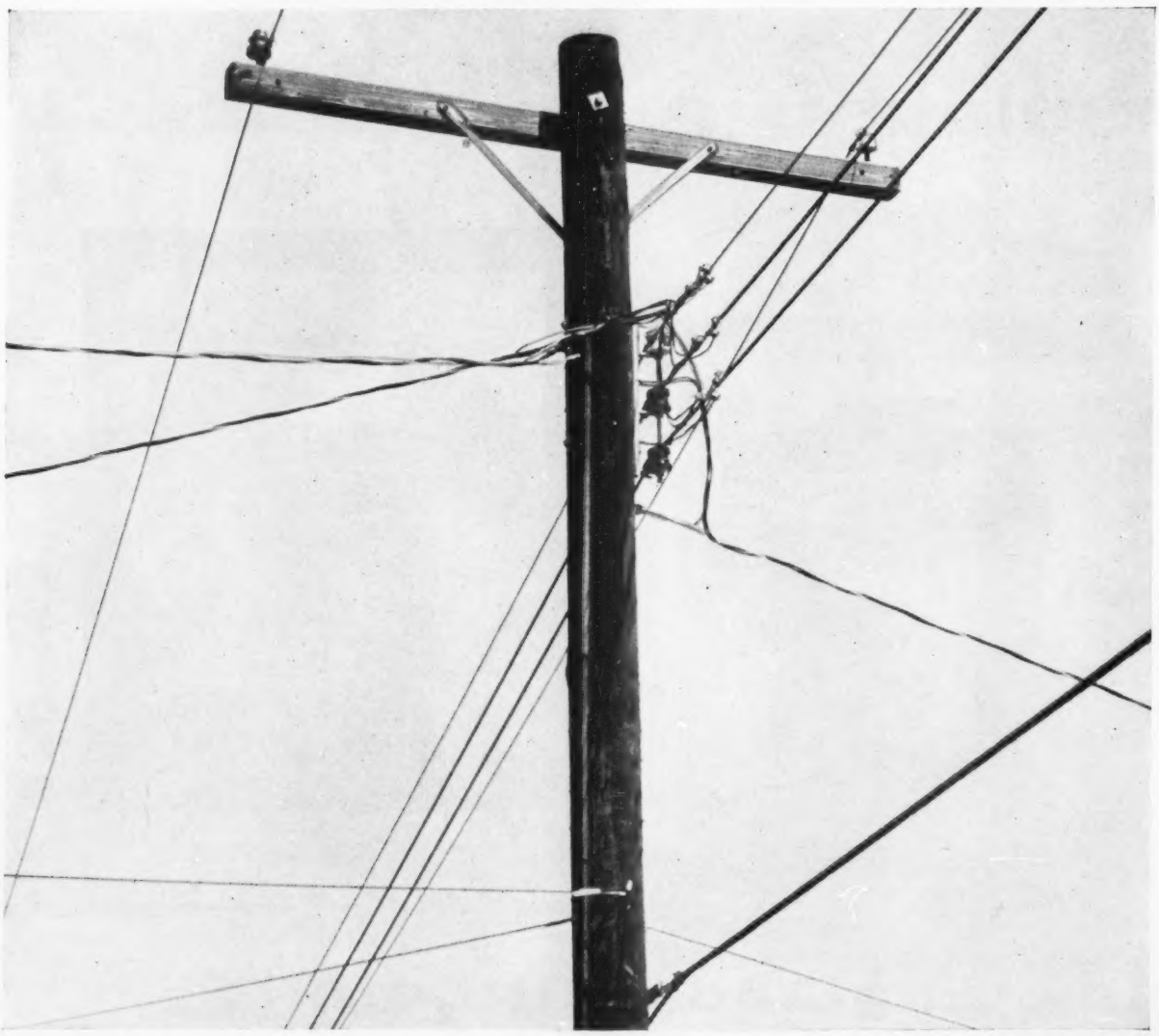
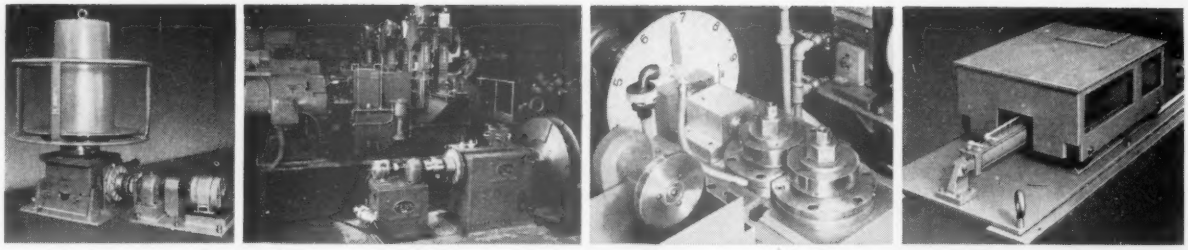
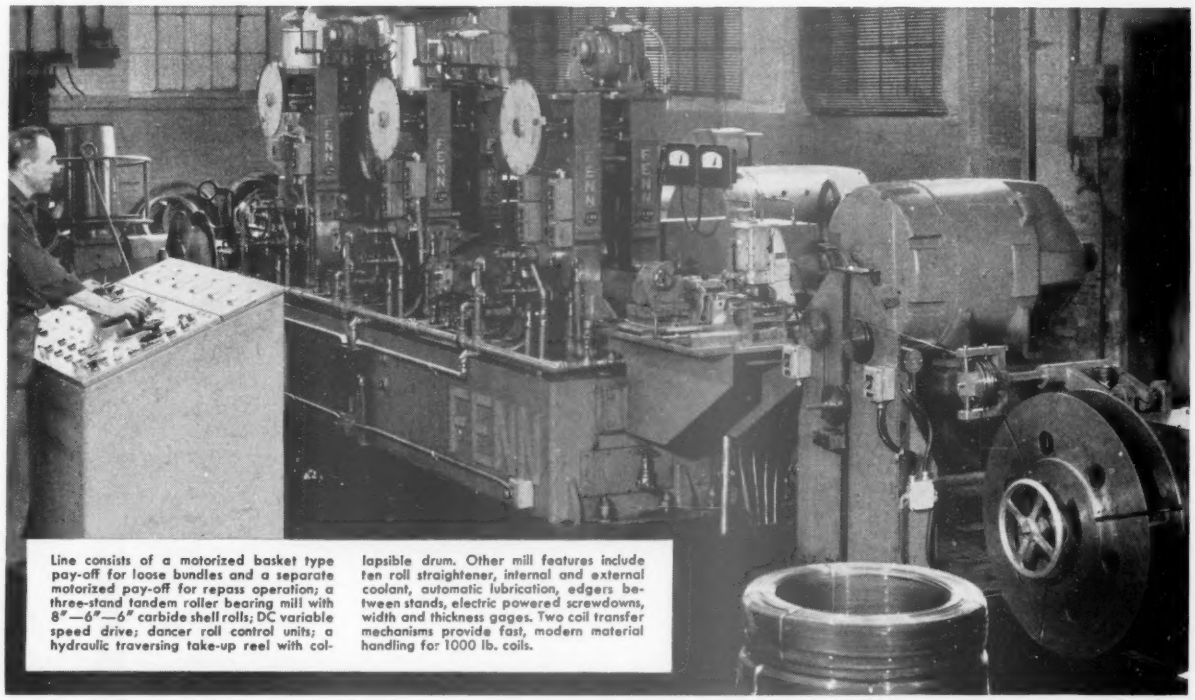




PRODUCING SPRING STEEL FLATS AT 3100 FPM



Line consists of a motorized basket type pay-off for loose bundles and a separate motorized pay-off for repass operation; a three-stand tandem roller bearing mill with 8"—6"—6" carbide shell rolls; DC variable speed drive; dancer roll control units; a hydraulic traversing take-up reel with collapsible drum. Other mill features include ten roll straightener, internal and external coolant, automatic lubrication, edgers between stands, electric powered screwdowns, width and thickness gages. Two coil transfer mechanisms provide fast, modern material handling for 1000 lb. coils.

pace-setting precision wire flattening mill

This three-stand tandem mill represents the finest in high speed precision wire flattening equipment. Installed at one of the nation's largest producers of spring steel, it offers significant advantages in flexibility, customer service, and finer stock finish. Production is greatly simplified with special material handling accessories, and the ability to produce flats from starting rounds entirely eliminates the customary slitting operation. Perhaps, like this progressive manufacturer, the time is at hand to evaluate your wire flattening equipment in terms of the economic justification for modernizing to the standards set by Fenn mills. Fenn's long experience is at your service. Fenn engineers will study your specific requirements and make recommendations for equipment to your competitive needs. The Fenn Manufacturing Company, Fenn Road, Newington, Connecticut.

Designed and Built by FENN

You are cordially invited
to visit with us at the

French Lick-Sheraton
Hotel

French Lick, Indiana

October 22 — 26, 1961

Visit our Suite

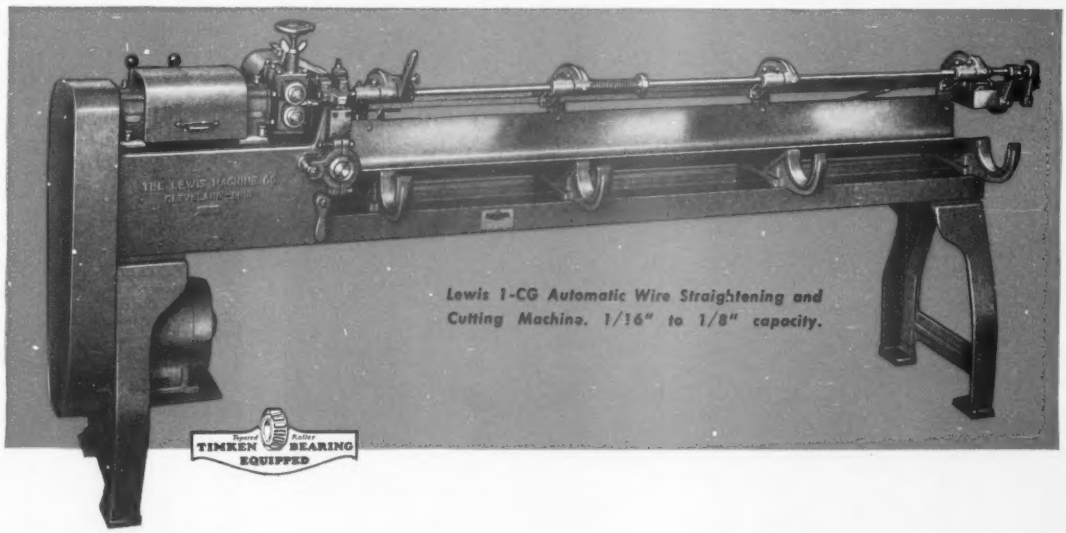
•

THE LEWIS MACHINE COMPANY

AMERICAN MACHINERY CO., INC.

STEEL & WIRE MACHINERY COMPANY

GREATER FLEXIBILITY IN WIRE STRAIGHTENING AND CUTTING WITH SELECTIVE SLIDING-GEAR TRANSMISSION



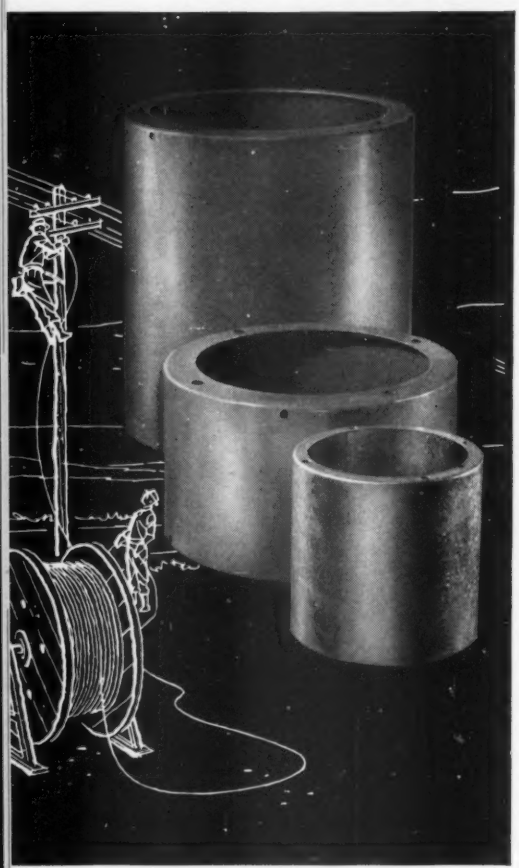
Lewis 1-CG Automatic Wire Straightening and Cutting Machine. 1/16" to 1/8" capacity.

Positive sliding-gear transmission permits selection of feed speeds from 35 to 150 FPM for all types of wire and rod. ■ Available with super-sensitive electric trip mechanism. ■ High-Speed, Five-Die Straightener Arbor, mounted on ball bearings. ■ Lewis engineered, simple, rigid, dependable . . . of best materials and workmanship. ■ Low in cost . . . economical in operation. ■ Ideal for manufacturers of stove and refrigerator racks, lamp shades, wire baskets, garment hangers, welding rod and other products where small diameter wire is used.

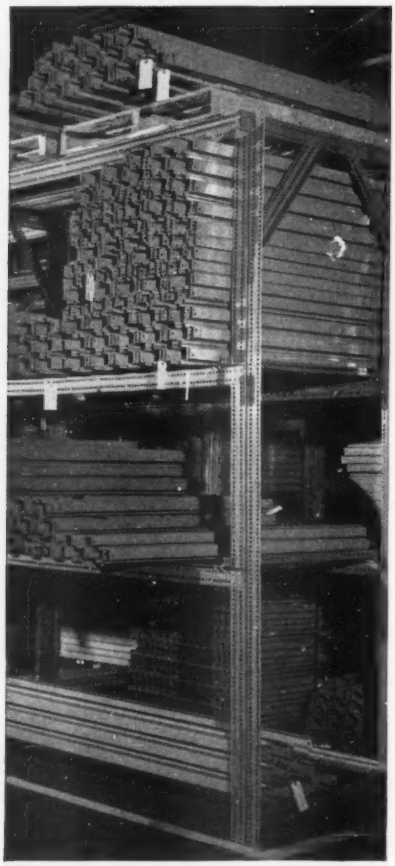
Lewis manufactures over 50 models of straightening and cutting machines to handle round wire from .012" to 1" and from 1/16" to 13/16" in square, hex and flat. Write or call us for information on your requirements.

THE LEWIS MACHINE COMPANY A DIVISION OF CURTIS MFG. CO.
3461 East 74th St. • Cleveland 27, Ohio • Tel. AV 1-3015

STANDARD REPUBLIC MATERIAL HANDLING PRODUCTS SOLVE STOCK, STORE, SHIP PROBLEMS

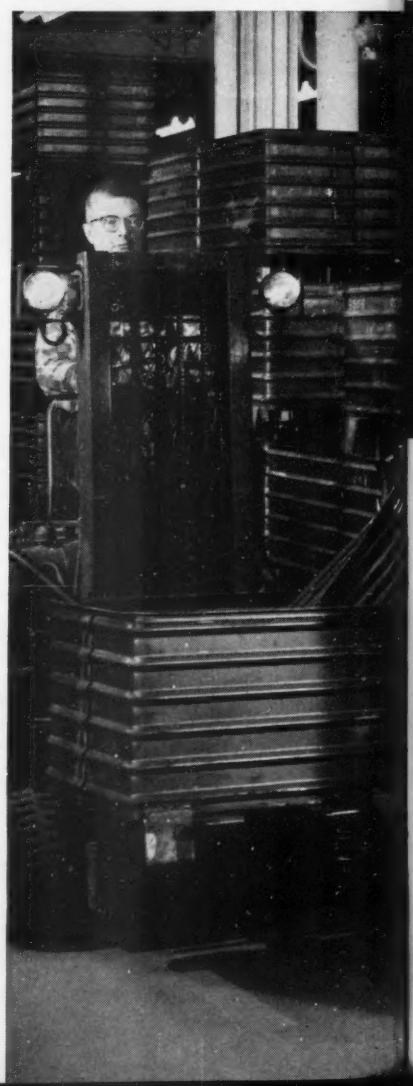


REPUBLIC FLANGED STEEL TRAVERSES save time, labor, money. Simple four-way assembly; no special tools required; long, trouble-free service. And Republic Steel Traverses are reinforced where it counts—at flange base and bolt holes. This makes possible the use of lighter gage steel, reduces weight 20%, with highest strength-to-weight attainable. Available in either plain, painted, or hot dip galvanized finish. Flange width, and bolt and drain holes furnished to your specification. Choose from the industry's most complete line. Over 100 sizes ranging from 12″ to 56″ diameter—6″ to 48″ lengths. Immediate delivery.



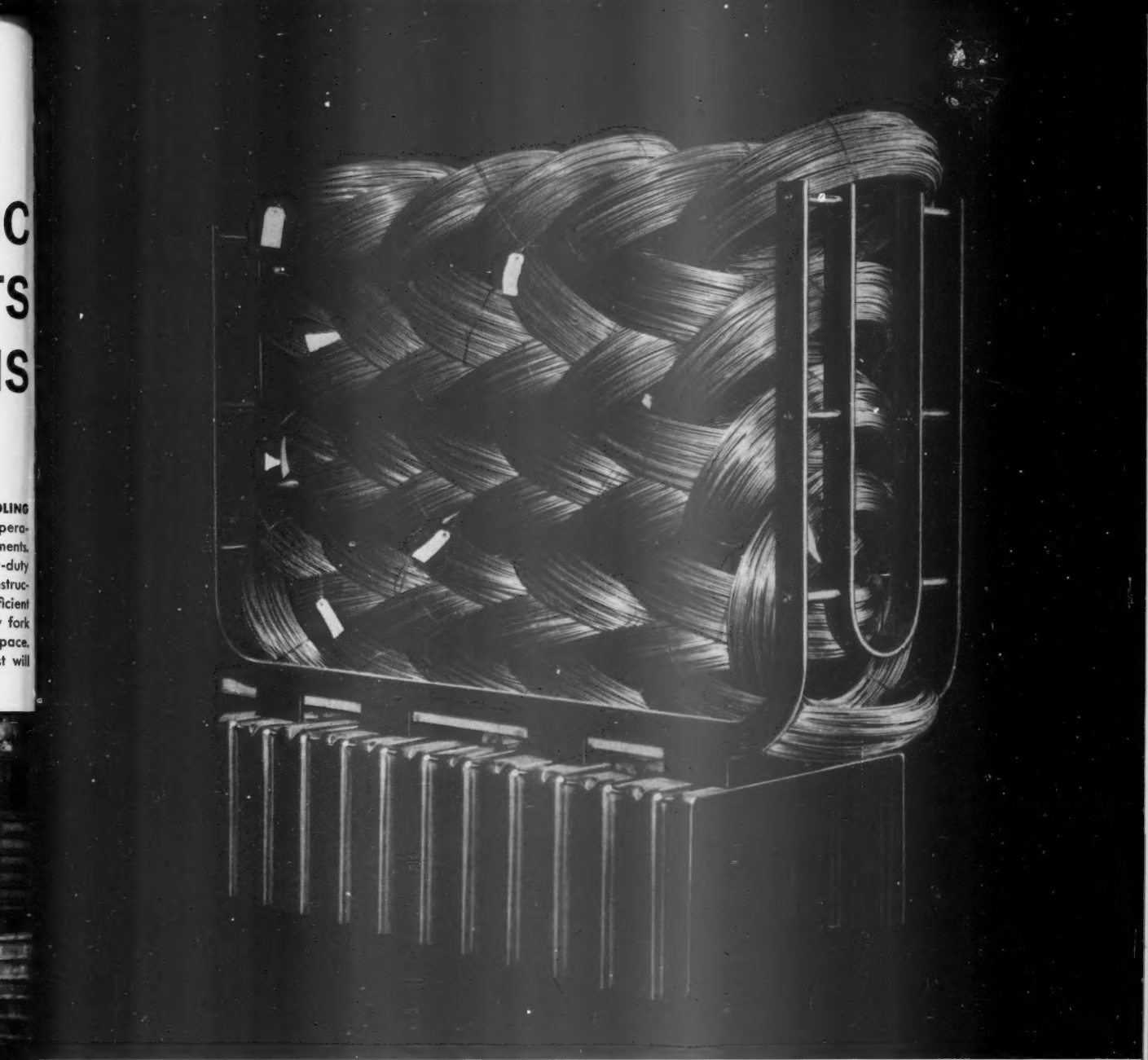
REPUBLIC METAL LUMBER® provides faster, stronger, safer framing. Ideal for erecting shop-built, tailor-made storage facilities for hard-to-handle stock-and-store materials. Erection is easy. Simply measure, cut, assemble with self-locking bolt and nut fasteners. METAL LUMBER is fabricated from cold rolled steel to assure uniform physical properties, and high strength-to-gage ratio. Bonderized after fabrication for complete protection of all exposed parts. Available in two gages, two widths, in standard bundles of either 10- or 12-foot lengths, complete with fasteners. Write for more information.

STANDARD REPUBLIC MATERIAL HANDLING UNITS save time in stack, store, ship operations. Reduce storage space requirements. Standard Republic Boxes feature heavy-duty stacking brackets and corrugated construction that combine to deliver long, efficient service at low per-year cost. Four-way fork channels simplify handling in restricted space. A Republic Material Handling specialist will work with you. Call or write today.



Strong, Modern, Dependable

Steel



REPUBLIC STACK 'N STORE UNITS provide a practical and economical solution to the problem of wire handling. These units are especially adaptable to bulk material, such as coiled wire, that does not require the use of completely enclosed sides. Specially designed "U" shape superstructure permits high stacking of coiled wire. Fully loaded superstructures are handled quickly and easily by crane. Or superstructures may be placed on skids and the entire unit readily moved to store-and-ship areas by lift trucks. Republic Stack 'N Store Units save valuable floor space, eliminate cluttered aisles, reduce handling time.

If you have a material handling problem, call your Republic-Berger representative. Republic Material Handling specialists will work with you, will recommend the right standard units to do your job right. Call or write today.

REPUBLIC STEEL

REPUBLIC HAS THE FEEL FOR MODERN STEEL

REPUBLIC STEEL CORPORATION
DEPT. WP-9534-A
1441 REPUBLIC BUILDING • CLEVELAND 1, OHIO

Please send more information on the following products:

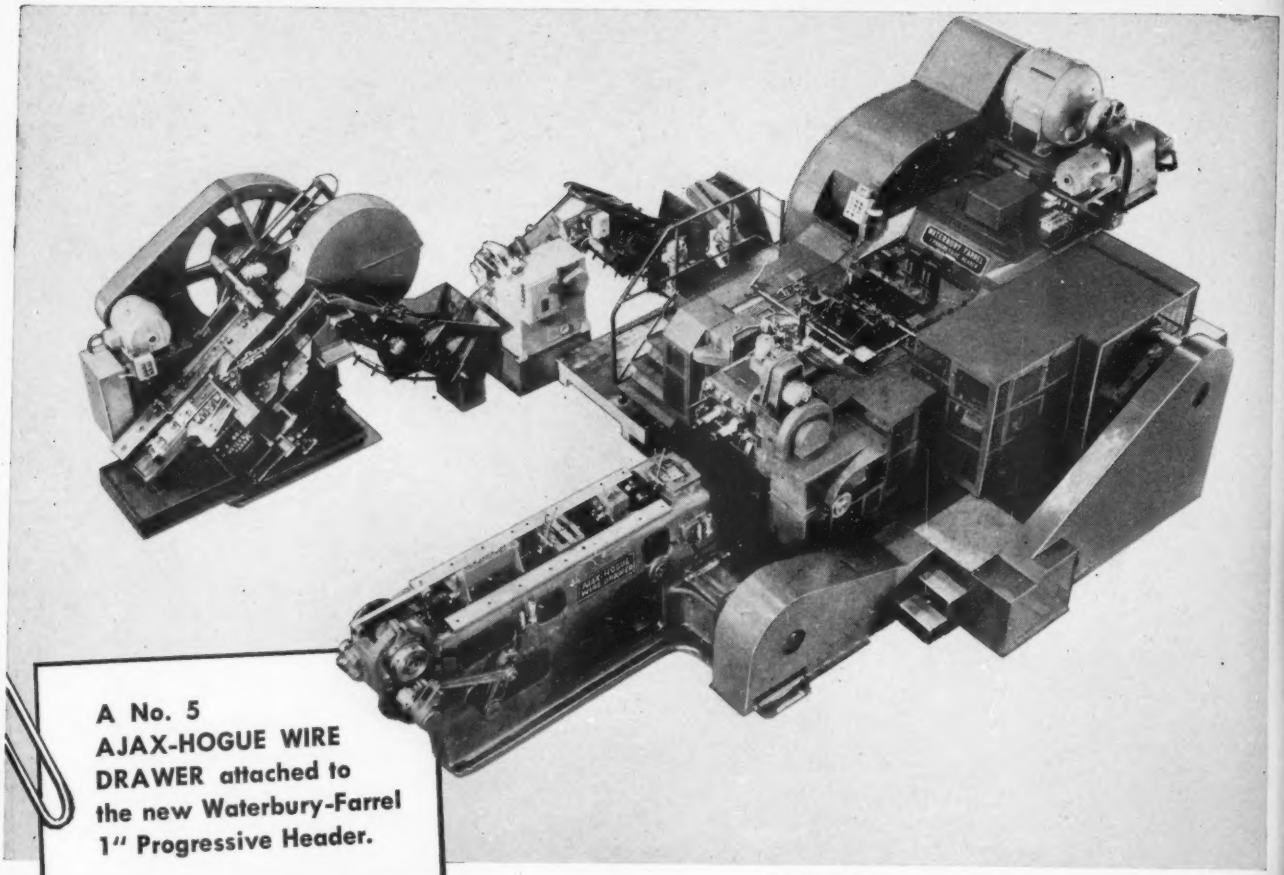
- ☐ Republic Flanged Steel Traverses
- ☐ Republic Material Handling Units
- ☐ Republic Stack 'N Store Units
- ☐ Please have a representative call
- ☐ METAL LUMBER

Name_____ Title_____

Company_____

Address_____

City_____ Zone__ State_____



A No. 5
AJAX-HOGUE WIRE
DRAWER attached to
the new Waterbury-Farrel
1" Progressive Header.

For Quality Production at Lower Cost
COLD HEADERS Need . . .

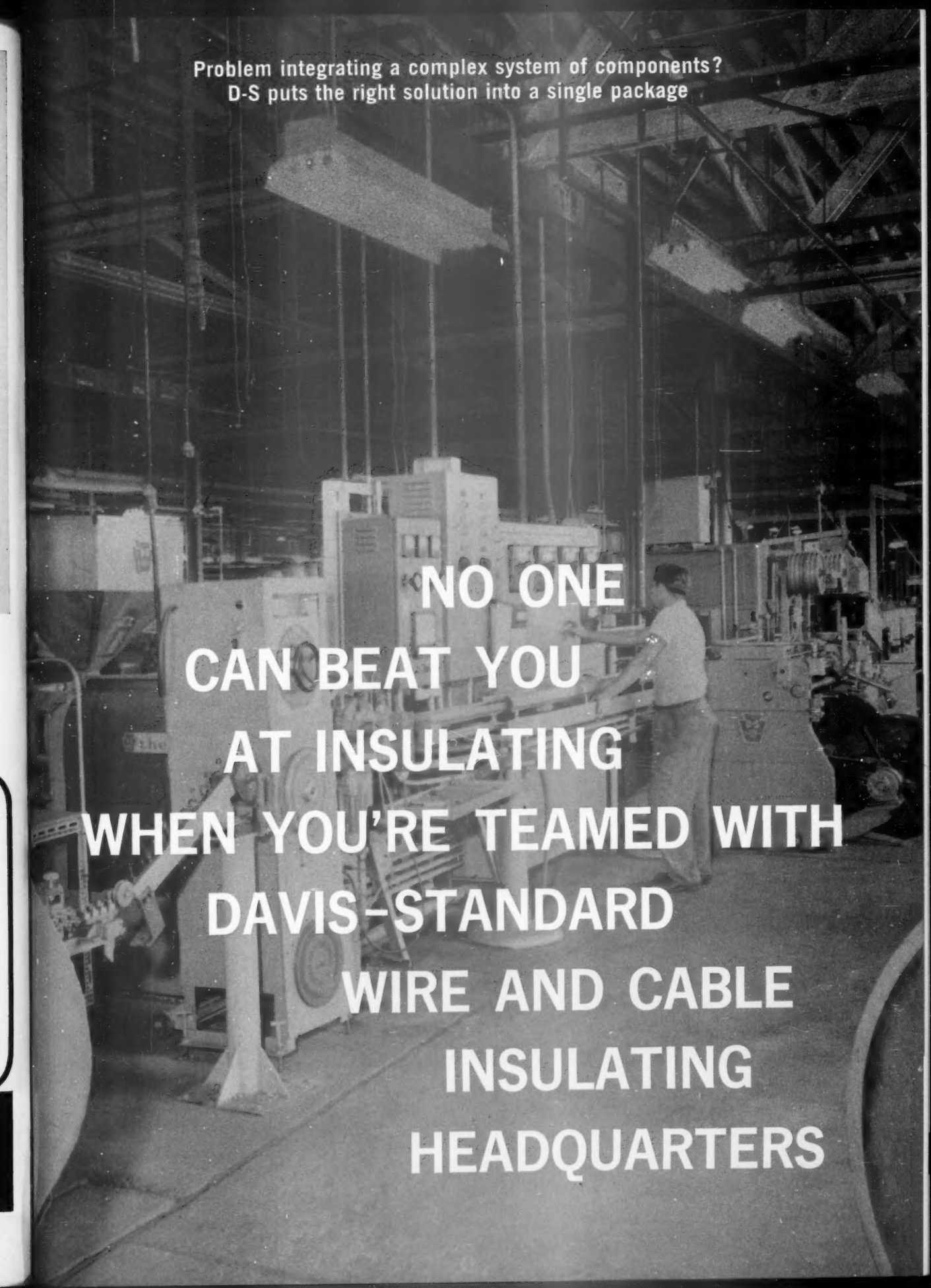
AJAX-HOGUE Wire Drawers

AN ATTACHMENT FOR HEADERS AND COLD NUT FORMERS

THE AJAX-HOGUE WIRE DRAWER is a complete wire drawing unit, custom designed to fit any make cold header or cold nut former. It cold draws wire in a straight line and coats wire from hot-rolled, pickled and limed rod as it feeds into the header. You are sure of uniformly accurate size wire from successive coils. A wire drawer attached to your header assures easier heading, improved products and increased production. *Write for Bulletin 111-A.*

DESIGNED AND BUILT BY

THE Ajax MANUFACTURING COMPANY
1441 CHARDON RD. CLEVELAND 17, OHIO
CHICAGO OFFICE, 110 S. DEARBORN ST., CHICAGO 3, ILLINOIS
WOOLDRIDGE CO. • BURLINGAME, CAL. • LOS ANGELES 22, CAL.

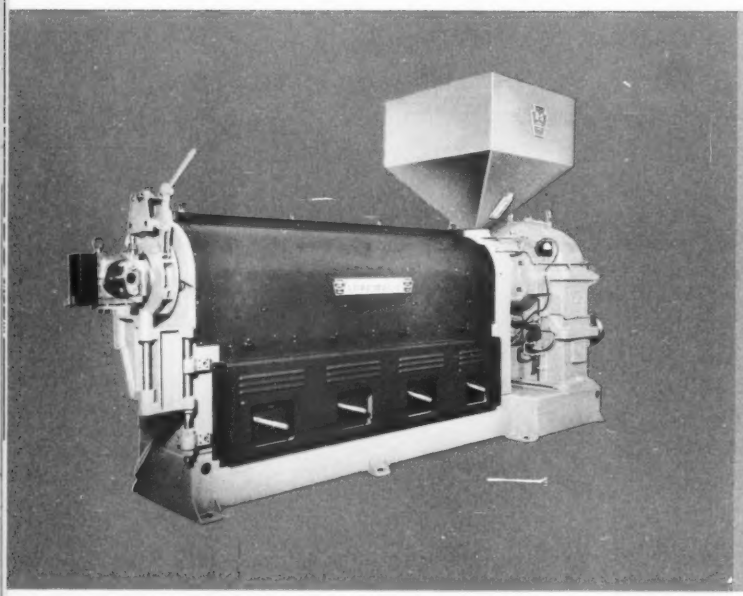

Problem integrating a complex system of components?
D-S puts the right solution into a single package
NO ONE
CAN BEAT YOU
AT INSULATING
WHEN YOU'RE TEAMED WITH
DAVIS-STANDARD
WIRE AND CABLE
INSULATING
HEADQUARTERS

GET THE WHOLE SYSTEM FROM DAVIS-STANDARD . . .

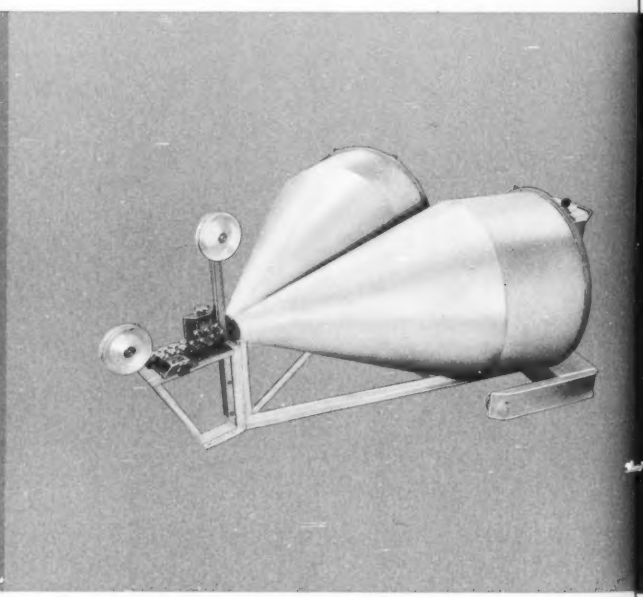
SINGLE-SOURCE INTEGRATION,

SINGLE-SOURCE SERVICE,

SINGLE-SOURCE RESPONSIBILITY



Example: this D-S Thermatic extruder maintains uniform temperature control **throughout,** making possible high screw speeds, and assuring excellent processing results with newest, most difficult compounds.



Example: this D-S payoff was developed specifically for continuous feeding at high speeds. It's the dual, stationary reel type — but Davis-Standard also has the one best payoff for **any** operation, any material, any system.

PLUS 7 OTHER D-S MATCHED COMPONENTS COOLING TROUGHS • WIRE MEASURING MACHINES • PRE-HEATERS

Cover Photo: Alphaduct Wire & Cable Co.

Merely to put together a wire insulating system that will **work,** you need an extruder plus a minimum of five or six additional components.

But it's a long, long way from simple workability to your own optimum standards of efficiency, accuracy, output speed and production costs. The odds are long that your ideal system will be a complex, custom-designed, one-of-a-kind **creation:** with a good many more than five or six components . . . with all components precisely matched and perfectly integrated.

It can add up to an enormous job of designing, specifying, buying, assembling, testing and installing all of the needed equipment for your system. **Especially if the components come from different sources, without having been tested and proved, each in combination with others.**

We submit that nine times out of ten you'll save yourself a lot of unnecessary coordination and integration headaches — yes, and often save money, too — by specifying a SYSTEM rather than merely the components that go into the system.

When you need a system, **buy** a system.

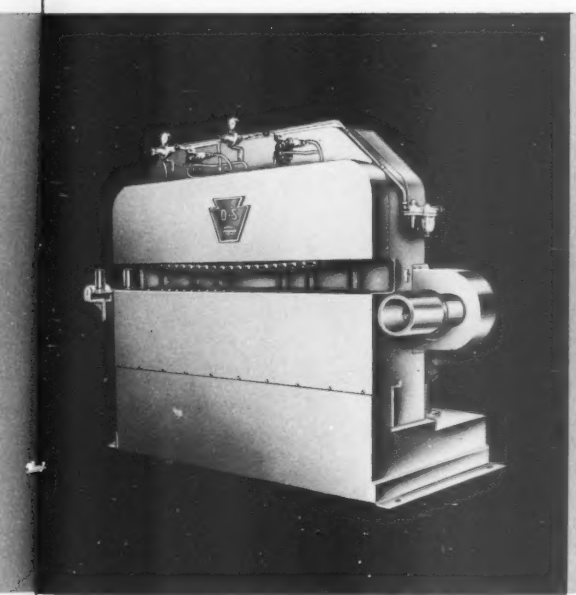
Get it from Davis-Standard, the one supplier best qualified to give you single-source integration, single-source service and single-source responsibility. The industry's Number One designer-builder of wire line equipment — the **one and only builder** of complete systems.

It might be the most profitable decision you can make in the increasingly complex job of insulating wire and cable.

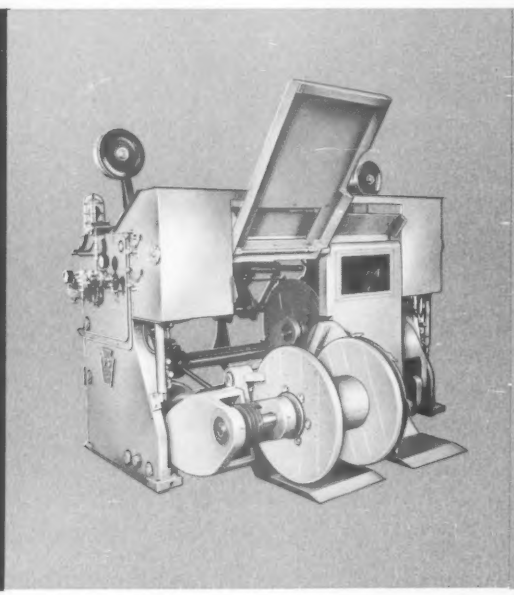
Integration. You get perfectly matched components in a precision-coordinated D-S system. No misfits, no weak links, no drags on the line. Your system is only as good as its weakest, slowest or least productive component. The D-S Matched Component "team" **always** works at peak capacity.

Service. As much of it as you need. From preliminary planning through design, installation, test-run — and beyond. And D-S service includes use of our complete laboratory facilities, with the industry's most highly instrumented full-size experimental extruder. You eliminate costly engineering time adapting unmatched units in a system.

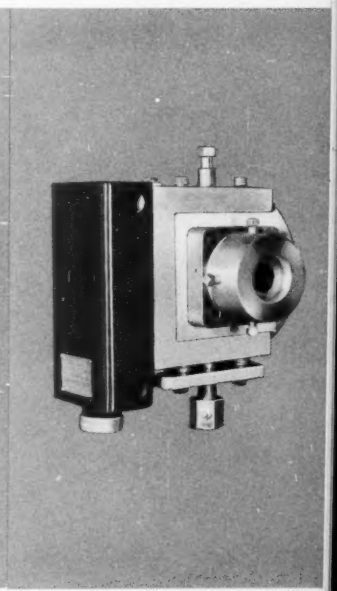
Responsibility. Davis-Standard guarantees the system as a whole, its long-life dependability, its cost-cutting, minimum-maintenance "on the line" productivity. No questions, no buck-passing. And **that,** we believe, is the most meaningful guarantee you can get!



Example: this D-S capstan is a caterpillar model, electrically coordinated with the extruder drive in a system designed for best results in production of heavier wire and cable. Integrated control means higher speeds.

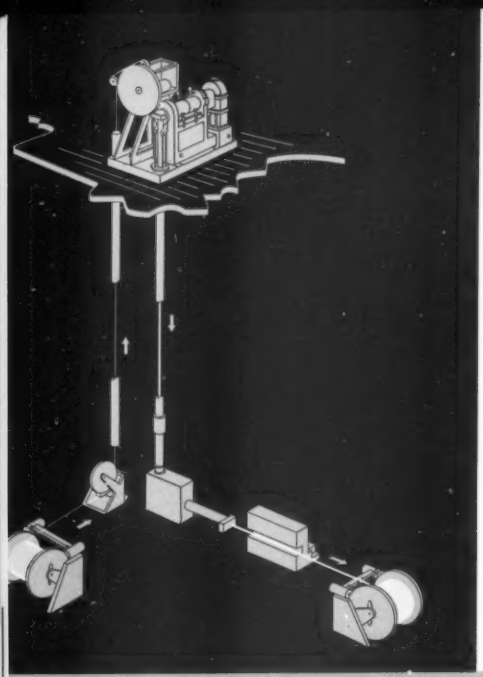


Example: D-S dual reel, high speed take-up. Until recently, the FPM speed of many systems was limited, held down by lagging takeup speed. Not with this one! Now in regular operation at over 4,000 FPM, it is designed for and capable of a maximum speed of 5,000.



Example: this is one D-S crosshead from among available units capable of handling anything from light wire to heavy multi-conductor cable. Yes, and special types for special systems—including yours!

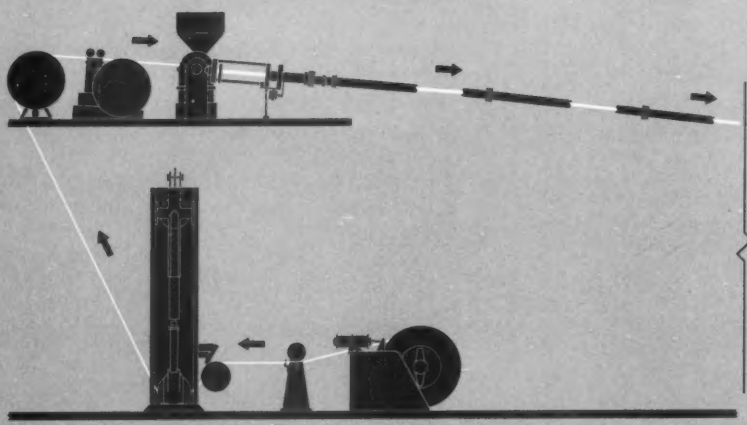
SPLICE BOXES • VULCANIZING TUBES • ACCUMULATORS OR DANCER CONTROL COLUMNS • SPARK TESTERS



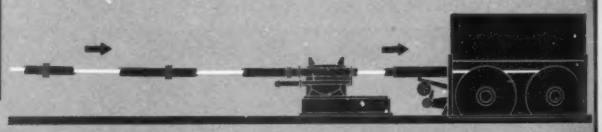
FROM TRANS-OCEANIC CABLE TO MISSILE WIRE—

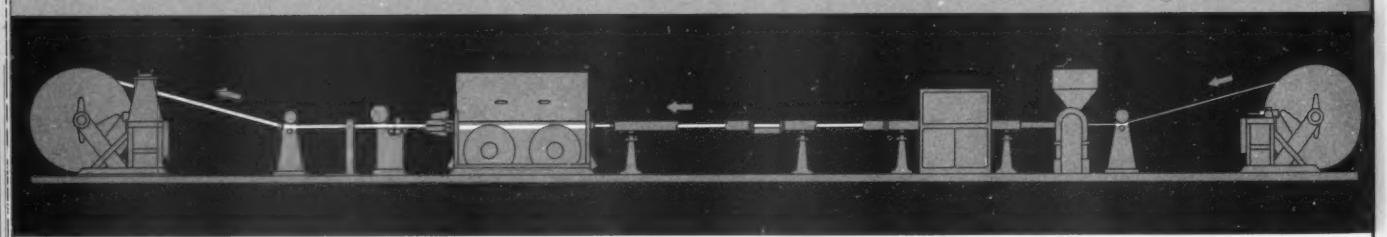
ONE OF THESE THREE DAVIS-STANDARD SYSTEMS WILL WORK BEST FOR YOU

VERTICAL For large heavy wall insulated cable, mounting the extruder and drag capstan in a tower assures uniform, concentric insulation regardless of weight or thickness. Commercially pioneered by Davis-Standard, Vertical CV's produce high-performance, trouble free insulation on large diameter cable most efficiently.



INCLINED For continuous production of wire up to 1,000 MCM, an inclined system offers the advantages of the horizontal line while avoiding the scuffing and marring of heavy uncured insulation. By inclining the initial length of the curing tube 1 to 10 degrees, the insulation sets sufficiently to allow further processing without damage or distortion.





HORIZONTAL For small wire sizes, high speed, continuous production is a competitive necessity. When your entire wire processing line is made up of Davis-Standard **Matched Components** practical production speeds of up to 5,000 FPM are possible. What's more, you get consistently high-quality production. For intermediate wire sizes, larger, more powerful equipment is required. Running at 2,500 FPM on #14 AWG wire demands more rugged equipment, and each component must be **system-coordinated** for top production, top quality.

FIND OUT MORE Ask your Davis-Standard man to tell you more about each of these three systems. He'll give you straight, uncompromising recommendations, because he represents **the one and only company that manufactures every component required to insulate wire and cable.** That's why no one can beat you at insulating when you're teamed with Davis-Standard.

D-S thermatic

DAVIS-STANDARD

Division of
FRANKLIN RESEARCH AND DEVELOPMENT CORPORATION

14 WATER STREET, MYSTIC, CONNECTICUT

MIYAZAKI

BAR MAKING COMBINER

DRAWING, STRAIGHTENING,

CUTTING, AND

POLISHING MACHINE

MODEL DC-SP-1

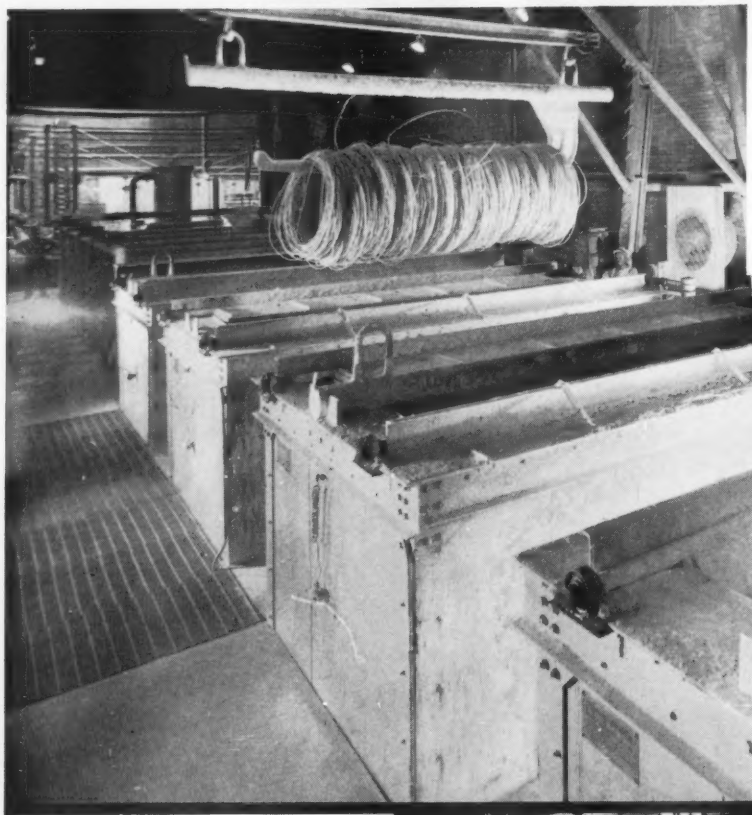
Our BAR MAKING COMBINER (Type DC-SP) is able to carry out continuously and automatically all processes of DRAWING, STRAIGHTENING by rolls, CUTTING to the determined length, STRAIGHTENING by rings and POLISHING of Bar-in-Coil materials (Both ferrous and non-ferrous) in one shift.

SPECIFICATION

Machine Size	Traction Power kg.	H.P. Required H.P.	Drawing Speed m/min.	Sizes of Products to be manufactured					
				Shape / material	○	⬡	□	▭	Cutting length m. (adjustable)
Size I	2.500	40	40, 30	Ferrous	4 – 13	5 – 13	4–11.8	max. 9×15	2 ~ 4
				Non-ferrous	4 – 15	5 – 13	4–11.8	max.11.8×15	
Size II	6.000	55	30, 22.5	Ferrous	10 – 20	10 – 18	10 – 18	max. 12×25	3 – 6
				Non-ferrous	10 – 25	10 – 22	10 – 22	max. 20×25	

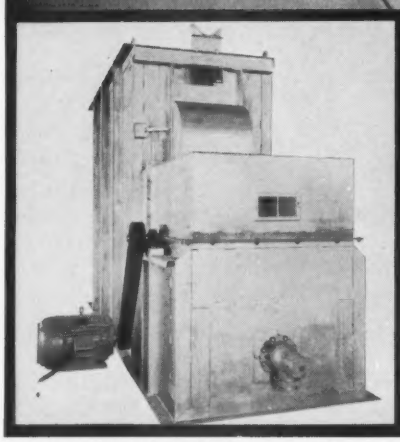
Miyazaki Iron Works, Ltd.
Kaizuka, Osaka, Japan.

carl mayer Designs, Builds and Installs all Types of ROD BAKERS

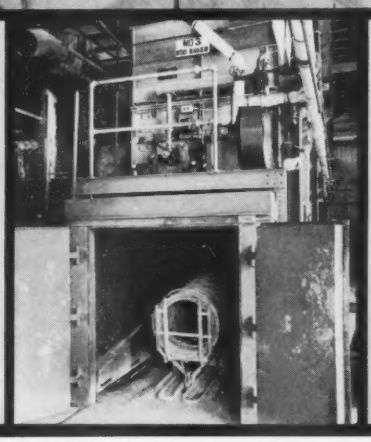


Carl Mayer Hi-Speed Rod Bakers, Tunnel Bakers, Continuous Bakers and specials . . . are now in service all over the world.

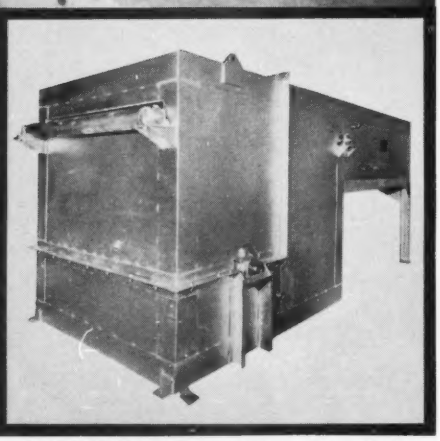
HI-SPEED ROD BAKER—with greater fuel economy and maximum efficiency resulting from exclusive heating arrangement and counter-balanced doors. Patented blow off feature for excess moisture removal.



PIT TYPE BAKER—with open top. Direct oil or gas fired heating. High capacity blowers.



TUNNEL BAKER—Indirect, oil or gas fired heating system. Positive temperature control. 6' 10" wide x 7' high x 40' 8" long—Capacity 6,000 lbs. per hour.



CONTINUOUS BAKER—used for either drying lime coating on wire continuously, or strip paint drying. Direct gas fired, recirculating heating.

HERE ARE JUST A FEW OF OUR MANY SATISFIED CUSTOMERS:

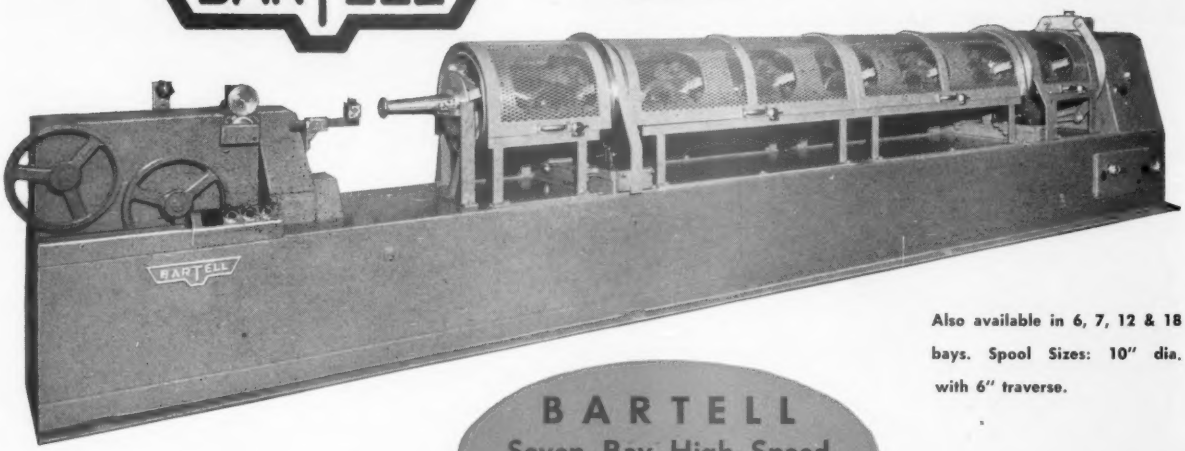
American Steel & Wire Co.
Atlas Steel Co.
Colorado Fuel & Iron Corp.
Crucible Steel Co. of America
Driver-Harris Co.
B. Greening Wire Co., Ltd.
Indiana Steel & Wire Co.
Jones & Laughlin Steel Corp.
Republic Steel Corp.
Sheffield Steel Div., Armco Steel Corp.
Steel Company of Canada
Thompson Wire Company
Wickwire Spencer Steel Div., Colorado Fuel & Iron Corp.

Write for Literature

THE carl mayer CORP.
20800 CENTER RIDGE ROAD CLEVELAND 16, OHIO
OTHER PRODUCTS: Heat Treating Ovens and Furnaces • Rod Bakers • Welding Rod Ovens • Paint and Ceramic Drying Ovens • Special Processing Equipment and Accessories

FOR THE BEST

BARTELL



Also available in 6, 7, 12 & 18 bays. Spool Sizes: 10" dia. with 6" traverse.

BARTELL
Seven Bay High Speed Strander
Model 7B-58-15

Frames are constructed of hot rolled shapes and plates to form a rigid box structure — Barrel is extruded 6062T-6 aluminum — Smooth starts through slip clutch driven by 7½ H.P. motor — Operators control station at front of machine — Main power control center at drive end — Electronically controlled automatic stop energizes solenoid operated brakes in event of wire breakage — Spool cradles and associated parts are completely interchangeable from one machine to another — Tungsten carbide wire guides throughout — Lay from ¼ in. to 5 in. long.

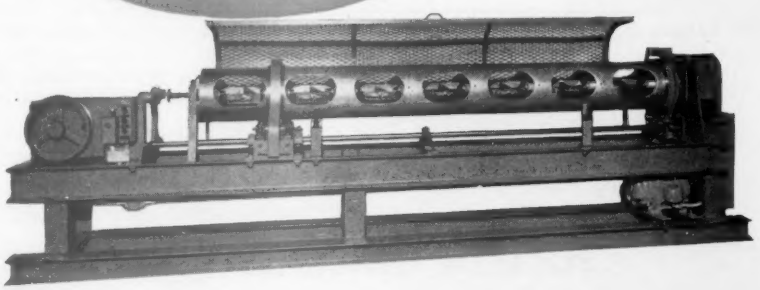
• CATERPILLAR CAPSTANS • SINGLE & MULTIPLE HEAD RESPOOLERS • WIRE STRANDERS
• TAKE-UP & PAY-OFF STANDS FOR PLATING EQUIPMENT

BARTELL

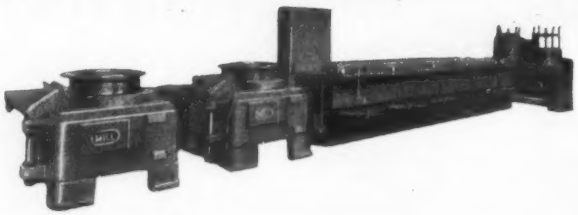
WE ALSO DESIGN AND BUILD SPECIAL EQUIPMENT TO MEET SPECIFIED REQUIREMENTS.

BARTELL
Seven Bay High Speed Strander
Model 7B-55

This precision, perfectly balanced machine features: rigid steel box structure-barrels of high strength ALCOA alloy — motor mounted below center of gravity — safe, positive drive — push button controls — carbide wire guides — interchangeable cradle assemblies — standard cradles taking 7" diam. x 4" Traverse Spools — 30 lengths of lay.



BARTELL MACHINE-TOOL CORP.
YACHT CLUB ROAD ROME, N. Y.
* Designers
* Manufacturers
* Engineers
* Consultants

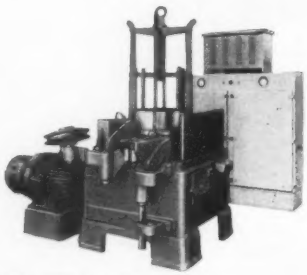


MULTIPLE STRAIGHT-LINE WIRE DRAWING MACHINE, Type MV 25, max. inlet dia. 8 mm. (hard steel), 12 mm. (mild steel), 14 mm. (copper wire).

MILL

MILL

MILL

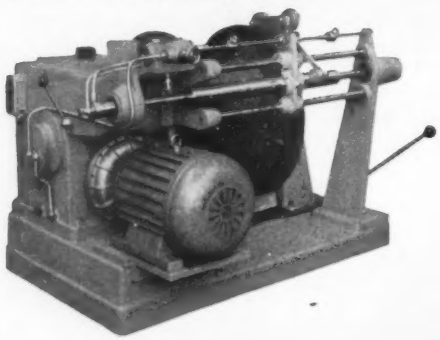


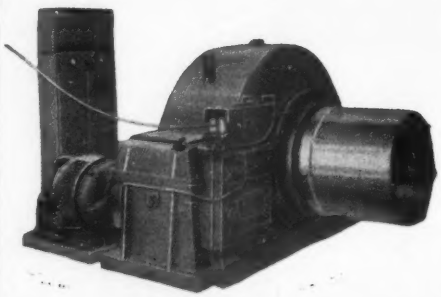
WIRE DRAWING BLOCK, Type TV 25/2, max. inlet dia. 6.5 mm. (hard steel), 8 mm. (mild steel), 12.7 mm. (copper wire).

NOVELTY

MILL

SPOOLER "MILL" Type RM 080, with Hydraulic Wire-Distributor. Maximum diameter of the Reel-Flange 800 mm.





WIRE DRAWING BLOCK Type TO 100, Max. Inlet Dia. 16mm. (Hard Steel), 20mm. (Mild Steel), 24mm. (Copper Wire).

The Societa Generale delle Macchine "Mill" announces the availability of the following equipment:

Single or double deck Bull Blocks • Multiple Pass Straight Line Wire Drawing Machines • Submerged System Wire Drawing Machines • Continuous Wire Drawing and Copper Coating Plant • Dual Reel Take-ups • Rotating Die Holders • Constant Tension Spoolers • Single Coilers • Multiple Coilers • Mechanical Descaler • Roller Pointing Machines • Rod Flippers • Electrical Winch • Rotating Flippers • Pull-in Dogs • Deburring Pliers.

GENERAL CATALOGUE ON APPLICATION.

SOCIETA GENERALE DELLE MACCHINE "MILL"

Sede Soc.: via V.Monti, 9, Milano.
Uffici: via Priv.Asti, 15, Milano.
ITALIA

Representative for U.S.A. Wanted

SHEFFIELD "ALUMINIZED" WIRE–
It's Coated With COMMERCIALLY PURE ALUMINUM

Sheffield was first to offer this wire coated with commercially pure aluminum. Sheffield metallurgists developed an exclusive patented process for applying this special aluminum coating to Sheffield Manufacturer's Wire.

This coating process not only gives the wire greater corrosion resistance, but also makes possible a better bond of aluminum to steel.

Teamed up with top-quality Sheffield-made steel, this coating of commercially pure aluminum gives you a wire of superior workability. You get dimensional and metallurgical uniformity. Dependable performance in your machines and your products. Faster production and less machine down-time. Plus the lustrous eye appeal of aluminum.

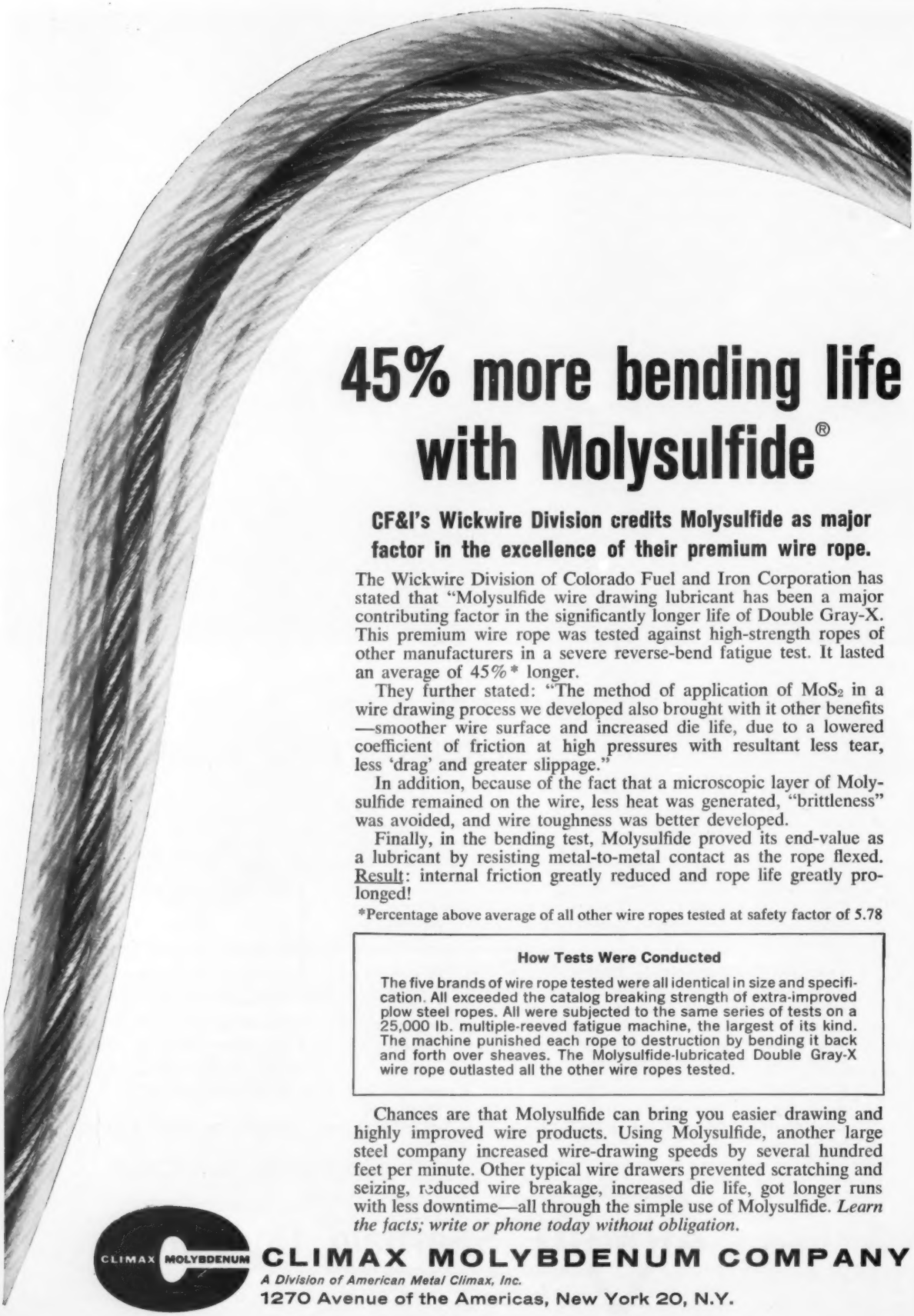
Let us tell you more about this Sheffield product, and what it can do for you. Get in touch with your nearest Sheffield office or write **Sheffield Division, Armco Steel Corp, Kansas City 25, Mo.**

SHEFFIELD
Aluminized
Wire

- AISI specifications 1006 and 1050
- 18 gauge through ¼"
- Packed in coils or on Sheffield Kone-Paks that give you on one continuous spool the equivalent of several ordinary coils of wire

WRITE FOR FREE SAMPLE

ARMCO Sheffield Division



45% more bending life with Molysulfide®

CF&I's Wickwire Division credits Molysulfide as major factor in the excellence of their premium wire rope.

The Wickwire Division of Colorado Fuel and Iron Corporation has stated that "Molysulfide wire drawing lubricant has been a major contributing factor in the significantly longer life of Double Gray-X. This premium wire rope was tested against high-strength ropes of other manufacturers in a severe reverse-bend fatigue test. It lasted an average of 45%* longer.

They further stated: "The method of application of MoS_2 in a wire drawing process we developed also brought with it other benefits —smoother wire surface and increased die life, due to a lowered coefficient of friction at high pressures with resultant less tear, less 'drag' and greater slippage."

In addition, because of the fact that a microscopic layer of Molysulfide remained on the wire, less heat was generated, "brittleness" was avoided, and wire toughness was better developed.

Finally, in the bending test, Molysulfide proved its end-value as a lubricant by resisting metal-to-metal contact as the rope flexed. Result: internal friction greatly reduced and rope life greatly prolonged!

*Percentage above average of all other wire ropes tested at safety factor of 5.78

How Tests Were Conducted

The five brands of wire rope tested were all identical in size and specification. All exceeded the catalog breaking strength of extra-improved plow steel ropes. All were subjected to the same series of tests on a 25,000 lb. multiple-reeved fatigue machine, the largest of its kind. The machine punished each rope to destruction by bending it back and forth over sheaves. The Molysulfide-lubricated Double Gray-X wire rope outlasted all the other wire ropes tested.

Chances are that Molysulfide can bring you easier drawing and highly improved wire products. Using Molysulfide, another large steel company increased wire-drawing speeds by several hundred feet per minute. Other typical wire drawers prevented scratching and seizing, reduced wire breakage, increased die life, got longer runs with less downtime—all through the simple use of Molysulfide. *Learn the facts; write or phone today without obligation.*

CLIMAX MOLYBDENUM

CLIMAX MOLYBDENUM COMPANY

A Division of American Metal Climax, Inc.

1270 Avenue of the Americas, New York 20, N.Y.

SPECIAL DESIGN UPON REQUEST

WIRE PREHEATERS

FOR FINE AND HEAVY GAUGE WIRES

by FEDERAL

Models PH 5
PH 10
PH 15
PH 20
PH 30

- Variable Heat Control
- Ammeter—Voltmeter
- Disconnect Switch
- Low Torque on Wheels
- Automatic Power On-Off
- Isolated Circuit
- 2 Triple Grove Contact Wheels
- Adjustable to Wire Line

OPTIONAL—Motorized Starting

Other FEDERAL Products

PAYOFFS • TAKE UPS • CAPSTANS • RESPOOLERS, 2-3 WHEEL MEASURING MACHINES • PAYOFF PAKS • COLLAPSIBLE COILING REELS • COILING MACHINES • PLANETARY CABLERS • WIRE PREHEATERS

TEST EQUIPMENT

SPARK TESTERS • HI POTENTIAL TESTERS • AC DC ELECTRONIC

THE FEDERAL MANUFACTURING CO. WALLINGFORD, CONN.
WIRE MACHINERY • TESTING EQUIPMENT

SALES REPRESENTATIVES

West Coast
THOMPSON ASSOCIATES
Palos Verdes Estates, Calif.

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PLASTICS & EQUIPMENT SALES
8232 Major Avenue, Morton Grove, Ill.

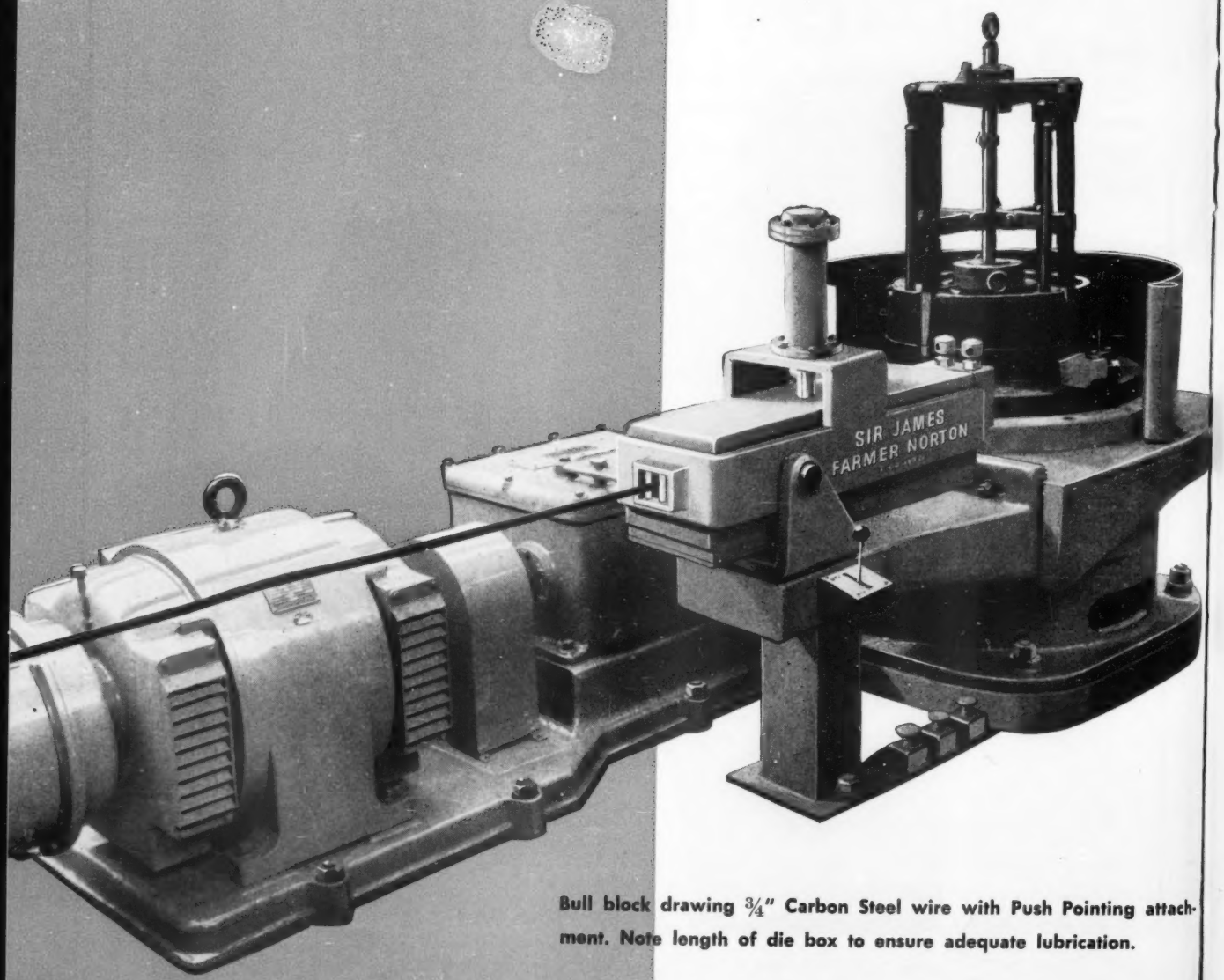
Canada
E. V. LARSON, LTD.
Toronto, Canada

Farmer Norton

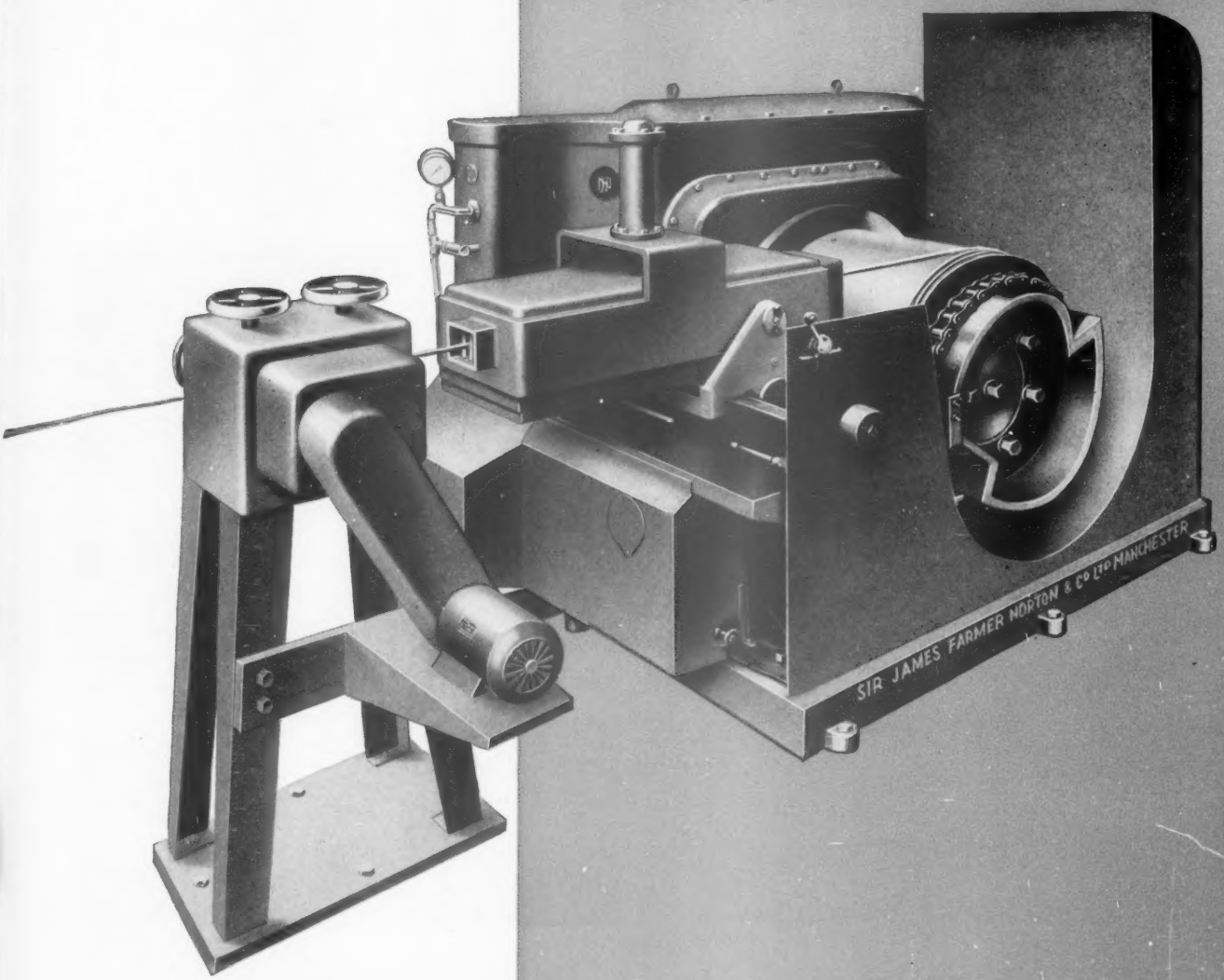
Push Pointing Units

for Wires from 1⅛" to ½" dia.

These Hydraulic Units can be fitted to practically any Bull block drawing heavy rods down to ½" diameter. The handling and pointing of heavy rods has always been a laborious and lengthy process. It is now possible to point and draw on the same machine. The Farmer Norton Push Pointing Unit straightens the first end and points the wire by driving it through the drawing die. The 'dog' may then be attached to the 'tag end' and drawing commenced.



Bull block drawing ¾" Carbon Steel wire with Push Pointing attachment. Note length of die box to ensure adequate lubrication.



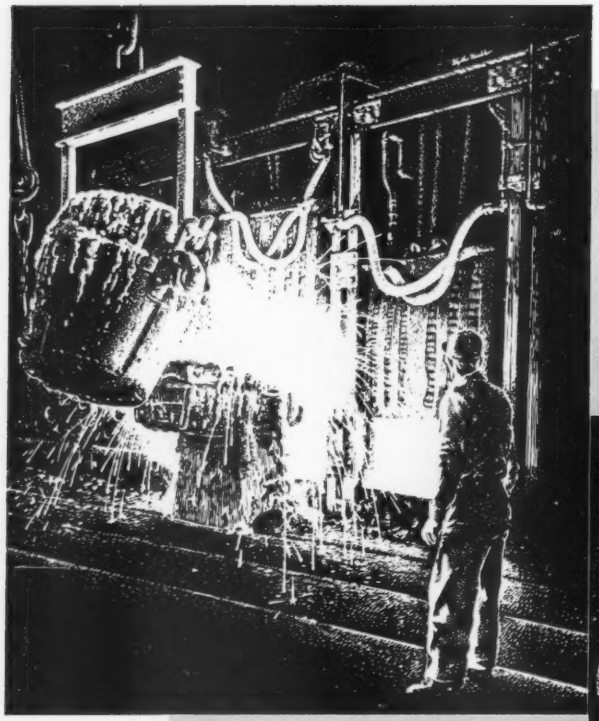
Horizontal bull block for 1⅛" diameter Bolt Wire. 36" diameter block. 30ft /min. 80ft /min. 110ft /min. Straightening roll and push pointer supplied.

Sir James Farmer Norton & Co. Ltd.

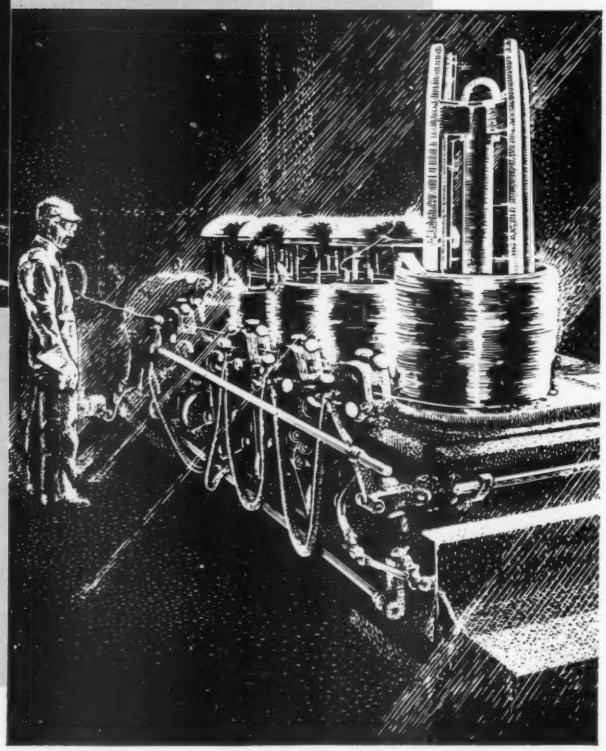
ADELPHI IRONWORKS, ADELPHI STREET, SALFORD, 3. LANCASHIRE

TELEPHONE: BLACKFRIARS 3613/4/5
TELEX NO. 66492

TELEGRAMS: 'AGRICOLA' MANCHESTER.



LACLEDE



Quality Wire... for every need!

A COMPLETE SELECTION—QUALITY CONTROLLED FROM OPEN HEARTH TO DELIVERED PRODUCT

From low carbon wire through medium high carbon wire, MB Grade spring wire, HB Grade spring wire, in all sizes, finishes and tempers.

Laclede specializes in metallurgical service that can quickly be of benefit to you and your product.

LACLEDE STEEL COMPANY

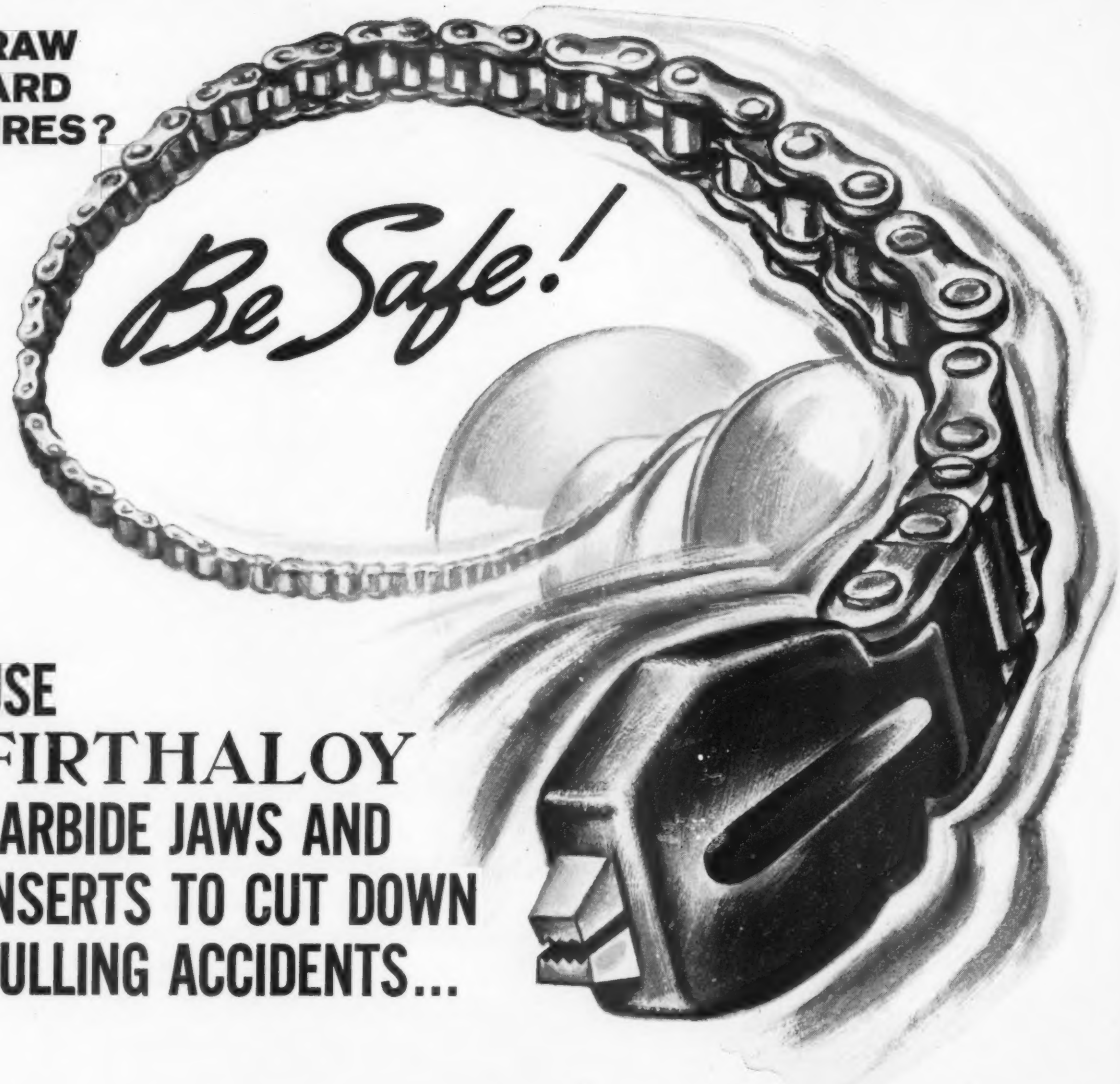
SAINT LOUIS, MISSOURI

Even-tempered spring wire means better springs. Wire makers who consider quality important assure themselves of complete and uniform treatment with modern Lee Wilson continuous heat treating lines. *Lee Wilson Engineering Co., Inc., 20005 Lake Road, Cleveland 16, Ohio.*

Lee Wilson

AMERICA'S FOREMOST BUILDERS OF WIRE HEAT TREATING EQUIPMENT

DRAW HARD WIRES?



USE FIRTHALOY CARBIDE JAWS AND INSERTS TO CUT DOWN PULLING ACCIDENTS...

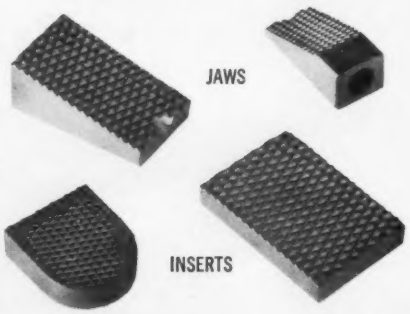
THEY OUTWEAR HEAT-TREATED STEEL 50 to 1 !!

Pulling high-carbon, stainless or high-tension spring wire through dies can be dangerous. Hard wires require great pulling power and a strong, sure jaw bite. If the grip slips, flying and thrashing jaws can cause serious injuries.

That's why you should use tough, wear resistant Firthaloy carbide puller jaws or inserts.

Carbide bites deep into the wire, holds tight. Firthaloy carbides are made even more dependable by strict quality control from ore to finished inserts. Performance-proved in actual mill operation, Firthaloy carbide jaws and inserts have demonstrated their holding power . . . resulting in tremendous savings in time, labor, money.

NOW STOCKED IN STANDARD SHAPES

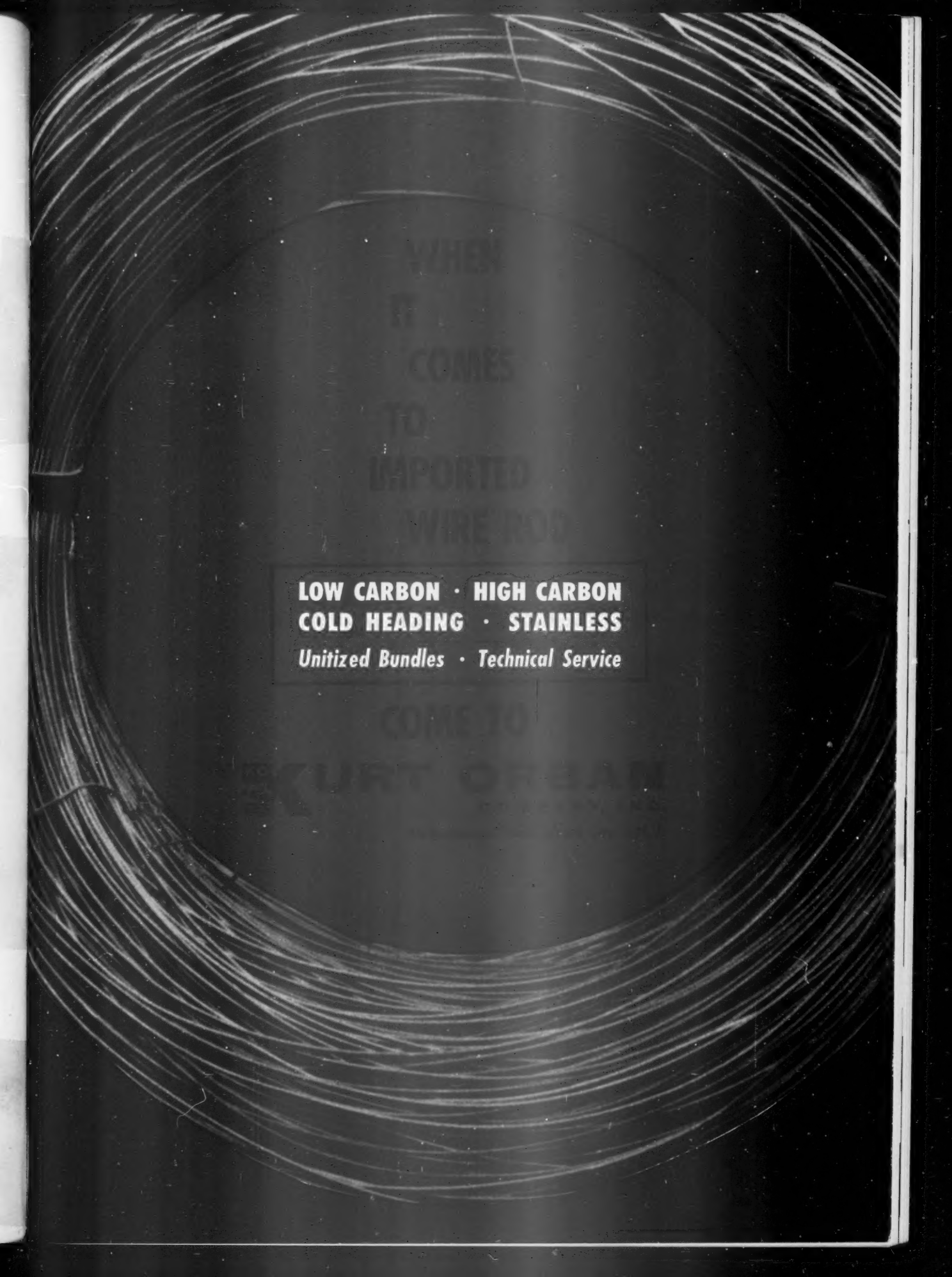


AND A WIDE VARIETY OF SIZES

PIONEER IN POWDER AND MOLTEN METALLURGY

Firth Sterling INC

3113 Forbes Ave.
Pittsburgh 30, Pa.
Offices and warehouses
in principal cities


WHEN
IT
COMES
TO
IMPORTED
WIRE ROD
LOW CARBON · HIGH CARBON
COLD HEADING · STAINLESS
Unitized Bundles · Technical Service
COME TO

DOSCO Wire Mill uses Cleveland

A tremendous number of Cleveland Tramrail cranes serve the many wire drawing blocks. They place wire onto the reels and strip drawn wire from the blocks.

This large room of nail machines is provided with complete coverage of Tramrail cranes. The carriers have rigid arms which make it easy to push carriers and cranes. The electric hoist push button is also conveniently located at the lower end of the arms.

Tramrail *Extensively*

Every department in the fine modern Etobicoke Plant of Dominion Steel and Coal Corporation, Ltd., in suburban Toronto, Canada, is equipped with Cleveland Tramrail Equipment.

Because Tramrail cranes roll so easily, even when loaded to capacity, nearly all are hand-propelled with only the hoists being motorized. The cleaning house gantry crane is, of course, power driven, having two motors on the bridge travel and one on the hoist.

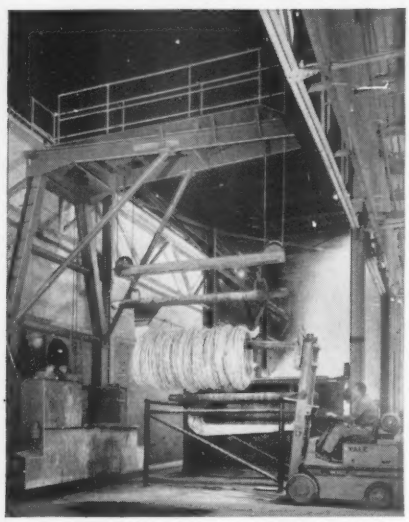
A big advantage recognized in Cleveland Tramrail equipment is its unique construction which makes it easy to relocate and adapt to various materials handling requirements.

Dosco is a large producer of nails, wire fencing and other wire products.

Cleveland Tramrail has had wide experience in the application of materials handling equipment for all phases of wire and rod production.

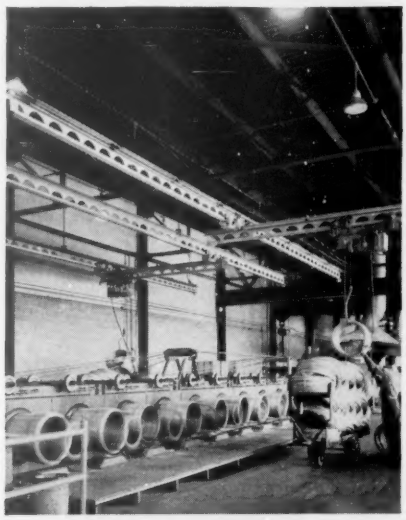
Our engineers will be glad to study your problems and make recommendations without obligation.

This battery of nail cleaning tumblers is served by a completely motorized three-runway crane. Bucket loads of nails are dropped directly into the tumblers. Cleaned nails are discharged from the tumblers into buckets in the pit below. These buckets are removed by the crane.



All wire is cleaned and lime-coated with the Cleveland Tramrail cleaning house crane. This is a very efficient operation, as only one man in the crane cab is required. Cleaned wire is lifted directly off the crane hook by a floor truck, thus eliminating a time-consuming step in handling.

Wire is quickly stripped from the continuous wire-drawing machines with these cranes.



Both ends of the patented annealing and galvanizing furnaces are served by Cleveland Tramrail equipment. Three hand-propelled cranes with electric hoists remove the coils from the take-up stands.

GET THIS BOOK!

BOOKLET No. 2008. Packed with valuable information. Profusely illustrated. Write for free copy.

CLEVELAND TRAMRAIL

Overhead Materials Handling Equipment

CLEVELAND TRAMRAIL DIVISION • THE CLEVELAND CRANE & ENGINEERING CO. • 9228 E. 288 ST. • WICKLIFFE, OHIO

WORKING WONDERS WITH WIRE: at Pittsburgh Steel Company's Monessen (Pa.) Fabric Dept.

Northern Indiana Steel's
rugged, new, operation-proved
WIRE CARRIERS and PAY-OFF REELS

PITTSBURGH STEEL'S $111,000,000 EXPANSION PROGRAM called for a new 125-ton 96-inch wire fabric machine, among many other improvements. To feed this monster, Pittsburgh's Monessen (Pa.) Works makes efficient use of 45 advance-design Northern Indiana Steel Supply Company Wire Carriers and Pay-Off Reels.

SAYS SID JOHNSON, FABRIC DEPT. SUPER:

"Because these wire carriers can safely carry up to 4,000 pounds—depending on the gauge and footage of wire—they help us reduce downtime on this new machine. We now need to weld new reels of wire only every 16 hours, the equivalent of two working turns."

In addition, 500 other Northern Indiana wire carriers have been found ideal by Pittsburgh for *storing* wire. The carriers are easily stacked, leaving maximum use of floor area. Result: good housekeeping with minimum effort.

DESIGNED AND PRODUCED TO YOUR SPECIFICATIONS

Wire Carriers and Reels that

- ✓ **FEED MORE SMOOTHLY**
- ✓ **CARRY UP TO 4,000 LBS.**
- ✓ **STACK AND STORE EASILY**

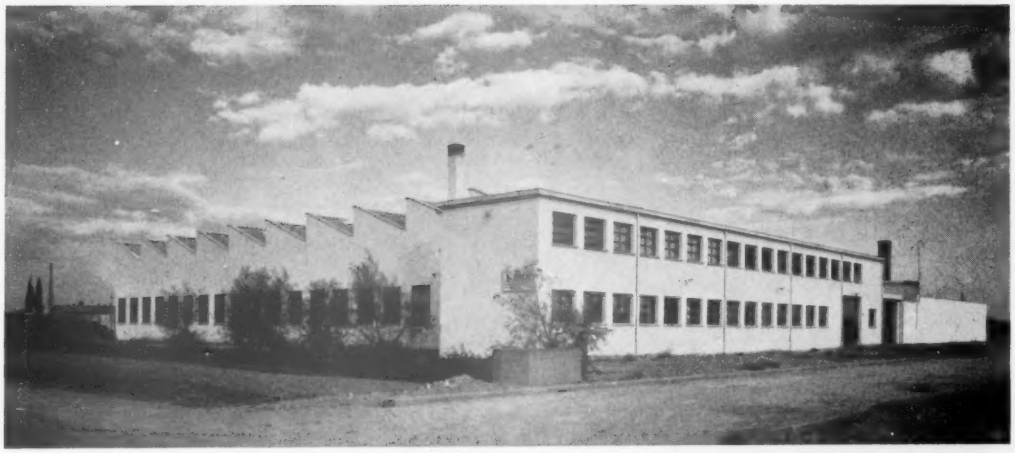
Let us know exactly what your operating needs require. If we don't already have it in stock, we're ready to make up your order as per your specifications. In any case, we'll be pleased to quote you promptly in quantities specified.

NORTHERN INDIANA STEEL SUPPLY CO., INC.

Fabricating Division, Michigan City, Indiana

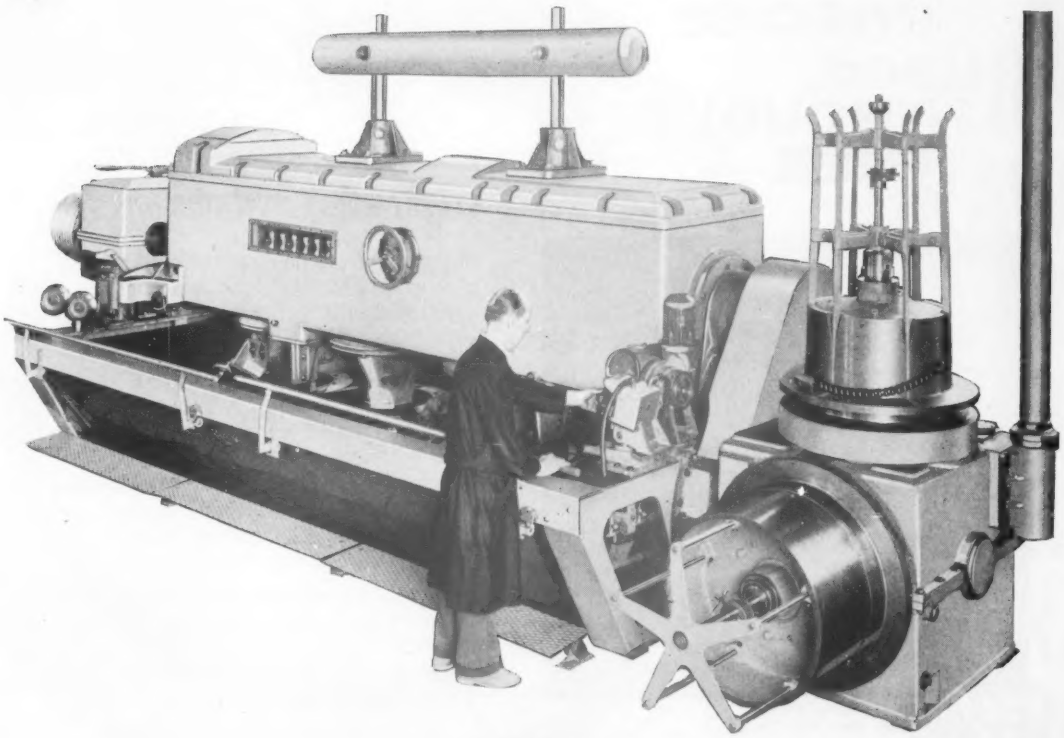
TELEPHONE TRiangle 4-3241

"SAMP"



Multiwire drawing machine – UNIVERSAL model MM-1/T

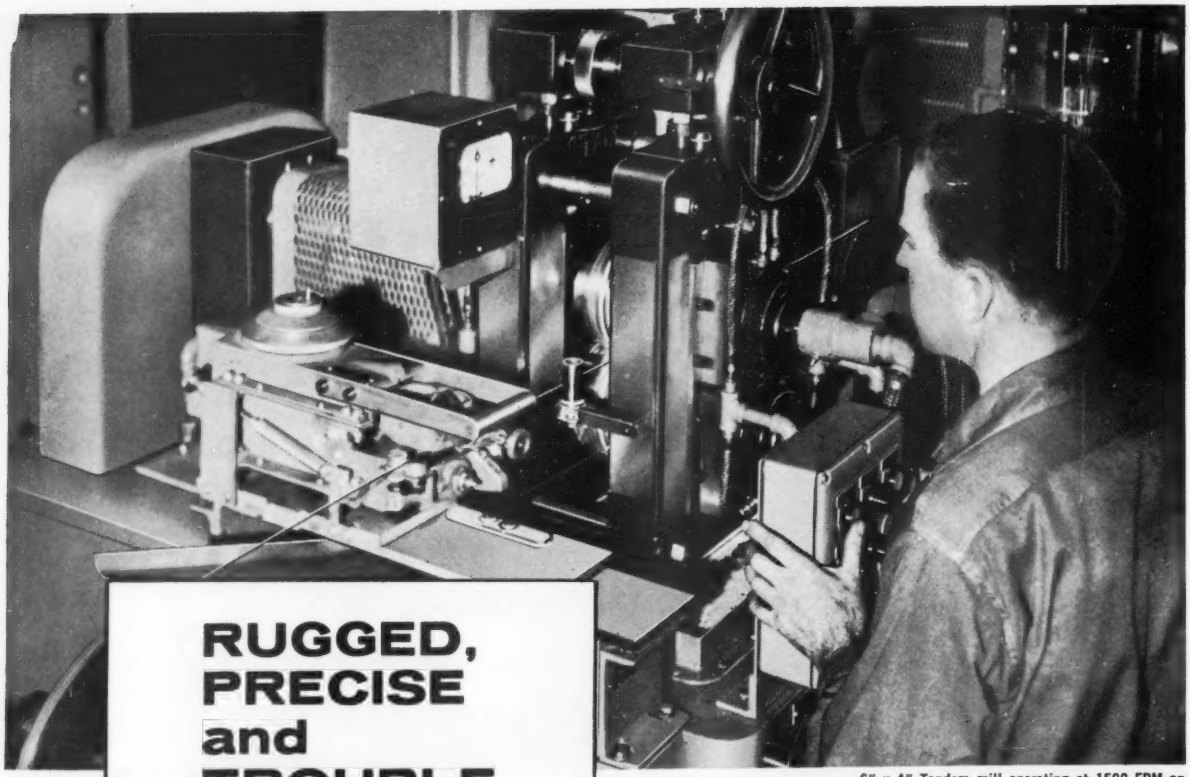
for drawing Trolley wires etc.



Soc. p. Azioni
Meccanica di
Precisione

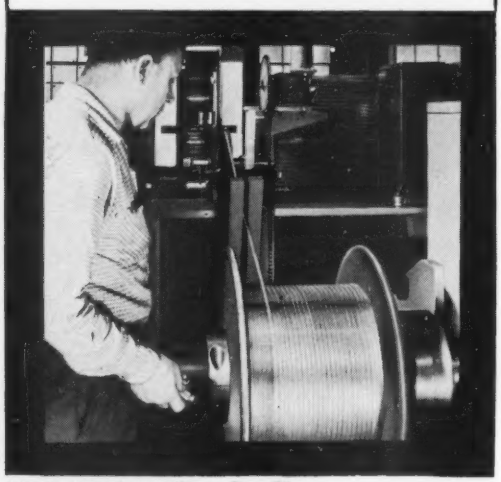
SAMP

Bologna
(Italy)
Via Galliera 12
telef. 235400
227400



6" x 4" Tandem mill operating at 1500 FPM on high carbon steel at Page Steel Division—ACCO.

RUGGED, PRECISE and TROUBLE FREE



1000 lb. traversing recoiler on 8" x 5" tandem line at Kagan Dixon Wire Corp.

STANAT WIRE FLATTENING MILLS

Stanat mills are designed to consistently give you extremely close tolerances combined with high speed production.

Simplicity of design insures minimum maintenance and frequently permits one man operation.

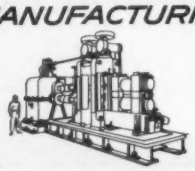
All Stanat mills include such quality features as completely enclosed permanently lubricated worm gear screwdowns; fully adjustable traversing recoiler; herringbone drive; anti-friction bearings at all critical wear points.

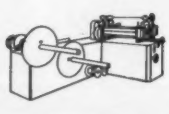
Stanat single and tandem wire flattening mills are available in sizes up to 10" roll diameter either as completely self-contained package units or as individual components for erection at your plant.

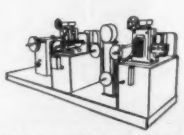
STANAT MANUFACTURING CO., INC.

500 SHAMES DRIVE WESTBURY, L. I., N.Y.

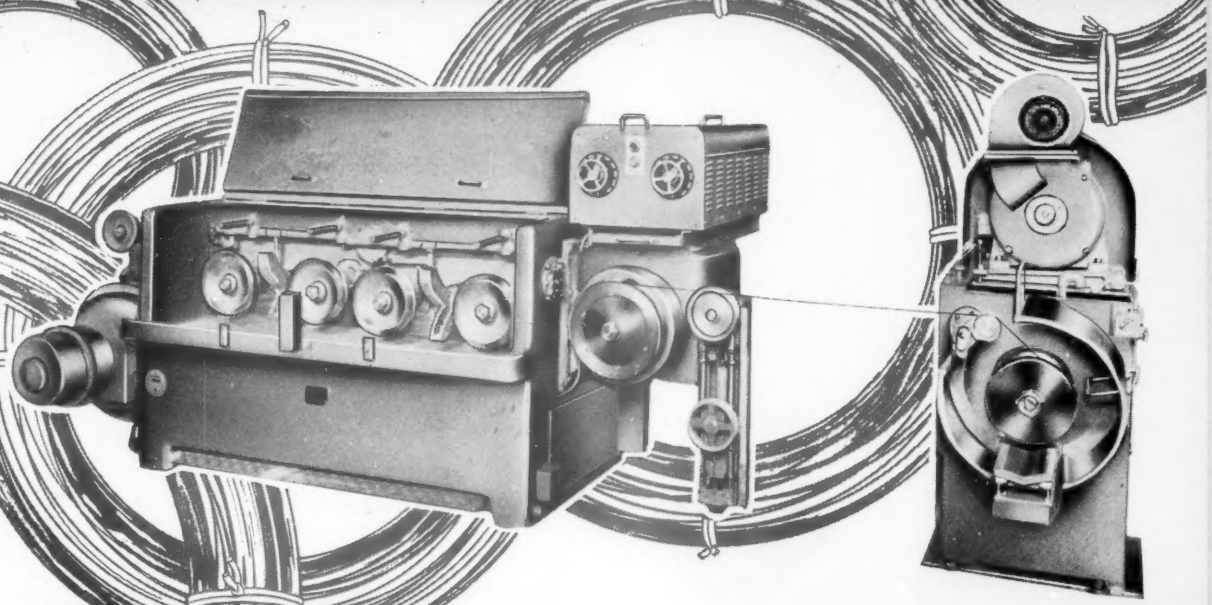
IN EUROPE: STANAT-MANN, ESSEX, ENGLAND







MFR'S OF ROLLING MILLS, GANG SLITTERS, WIRE FLATTENING MILLS, ROLLER LEVELERS AND BULL BLOCKS



MODEL CH-17S

WIRE DRAWING MACHINE FOR COARSE FINE WIRE

SPECIFICATION:

Entry diam.	2.3 mm
Finished diam.	0.65 mm to 0.32 mm
Number of dies	17
Finishing speed	1300 m/min.
Power required	50 HP

SHOWA MACHINE WORKS LTD.

No.16, Naka 3-chome, Mitezima, Nishi-Yodogawaku, OSAKA, JAPAN.

SHOWA

THE MONTGOMERY COMPANY

EST. 1871

WINDSOR LOCKS, CONNECTICUT

NATIONAL 3-3336

BARE ELECTRIC TINSEL CONDUCTORS

FOR USE IN TELEPHONE, RADIO, SHAVER AND HEARING AID CORDS. BARE TINSELS ALSO FOR VOICE COIL LEAD WIRES ON LOUD SPEAKERS. SPECIALLY ENGINEERED CONSTRUCTIONS AVAILABLE.

FINE WIRES

NON-FERROUS FINE WIRES

COPPER • OFHC • CADMIUM COPPER, ALSO COATED WITH TIN • SILVER, ETC. HARD OR ANNEALED. ALUMINUM, PUT UP SINGLE END ON SPOOLS OR MULTIPLE WOUND ON BRAIDER BOBBINS. ALSO STRANDED.

FLAT WIRE
(Tinsel Lame)

FLAT WIRE

FOR SHIELDING • BRAIDING • FLAT CONDUCTORS FOR RIBBON TYPE FLEXIBLE CABLES • RADIATION DETECTORS AND TUNING DEVICES • CABLE DRAIN WIRE. ALSO OTHER ELECTRONIC USES.

KNITTED MESH AND CURLED WIRE — FLAT AND ROUND

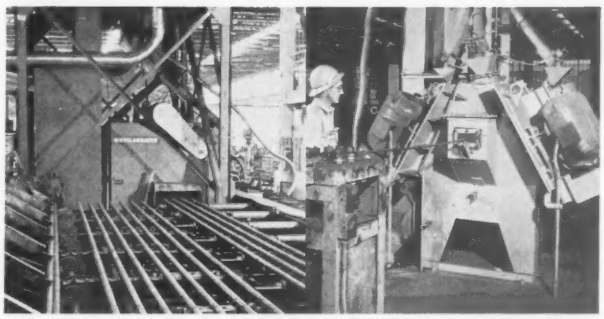
FOR ELECTRONIC SHIELDS • AIR, GAS AND OIL FILTERS • SHOCK ABSORBING PADS • POT CLEANERS AND MANY OF THE CLEANING APPLICATIONS IN BAKERIES • MEAT PROCESSING PLANTS AND RESTAURANTS.

FOR PROMPT DELIVERY
WRITE — WIRE or PHONE

THE MONTGOMERY COMPANY

25 CANAL STREET Est. 1871 Tel.: National 3-3336 **WINDSOR LOCKS, CONN.**

experience: vital ingredient of Wheelabrator's® success in wire descaling



Machine at left simultaneously descales four rods up to 4½" diam. Machine at right illustrates typical single-strand wire descaling cabinet.

A demonstration of WHEELABRATOR'S

VITAL VALUES

In the mechanical descaling of rod and bar stock, Wheelabrator offers you the vital experience of scores of successful, profitable installations. Leading producers of wire and wire products are now enjoying the competitive advantage inherent in automated manufacturing methods and freedom from the problems associated with acid pickling, made possible by Wheelabrator abrasive blast descaling.

Rod can be straightened, cleaned, coated, drawn and cold-headed in one continuous, straight-line operation, in single or multiple strands, at speeds up to 600 fpm. Multiple handling of coils and bar stock through batch processing is eliminated. And, the minutely cupped surface produced by the Wheelabrator method provides better drawing characteristics, and improved adhesion of coatings.

To reduce your descaling costs, eliminate the pickle house and combine cleaning with manufacturing processes, investigate Wheelabrator airless blast descaling. Write for complete information.

VITAL VALUES FOR INDUSTRY

WHEELABRATOR

WIRE ROD DESCALING

WHEELABRATOR CORPORATION, 389 S. Byrkit St., Mishawaka, Indiana, In Canada, WHEELABRATOR CORPORATION OF CANADA, LTD. 1901 Birchmount Rd. P.O. Box 490, Scarborough, Ontario

A subsidiary of Bell Intercontinental Corp.

"Tough-to-make"
Cold-Headed Products like these . . .

- Tubular Rivets (Punch Extruded).
- Non-threaded, multi-diameter, head and shoulder parts, drilled or not drilled.
- Washer and binding head screws with rolled threads.
- Special design fastenings and other small parts of intricate shape, with or without requirements for drilling or threading.

. . . become "routine" with

SCOVILL EXTRUDED Cold-heading WIRE

(Cartridge Brass, 70%)

MADE IN U.S.A. TO THE STANDARDS OF AMERICAN INDUSTRY

IT HELPS YOU ELIMINATE

1. OUT-OF-ROUND HEADS
2. INCOMPLETE FILLING-OUT OF HEADS AND SHOULDERS
3. ROUGH "ORANGE PEEL" EFFECT
4. UNSOUND HEADED PARTS
5. RED STREAKS AND STAINS
6. NON-UNIFORM FLOW

Scovill furnishes this Cold-Heading Wire in non-welded coils up to 250 lbs. each.

SCOVILL®

Scovill Cold-Heading Wire is extruded from CONTINUOUS-CAST brass billets by the hot extrusion process, then cold-drawn and annealed in accordance with closely controlled mill procedures.

CONTINUOUS CASTING produces *more uniform metal* than any other process, both in chemical composition and in freedom from casting flaws or other variations.

Scovill has standardized on *Cartridge Brass,* 70% for wire to be used in cold-heading operations. This alloy has a 5% HIGHER COPPER CONTENT than is generally found in brass cold-heading wire and is more ductile.

Prove this on your next wire order. Let us help you specify the proper closely controlled Scovill temper to produce more nearly perfect headed brass parts . . . whether you require "flow" characteristics for heading, or "flow" plus essential rigidity for secondary machining.

made better to bring out the ***BEST*** *in your products*

Scovill Manufacturing Company, Mill Products Division, 99 Mill St., Waterbury 20, Conn. Phone PLaza 4-1171.

12SC58R

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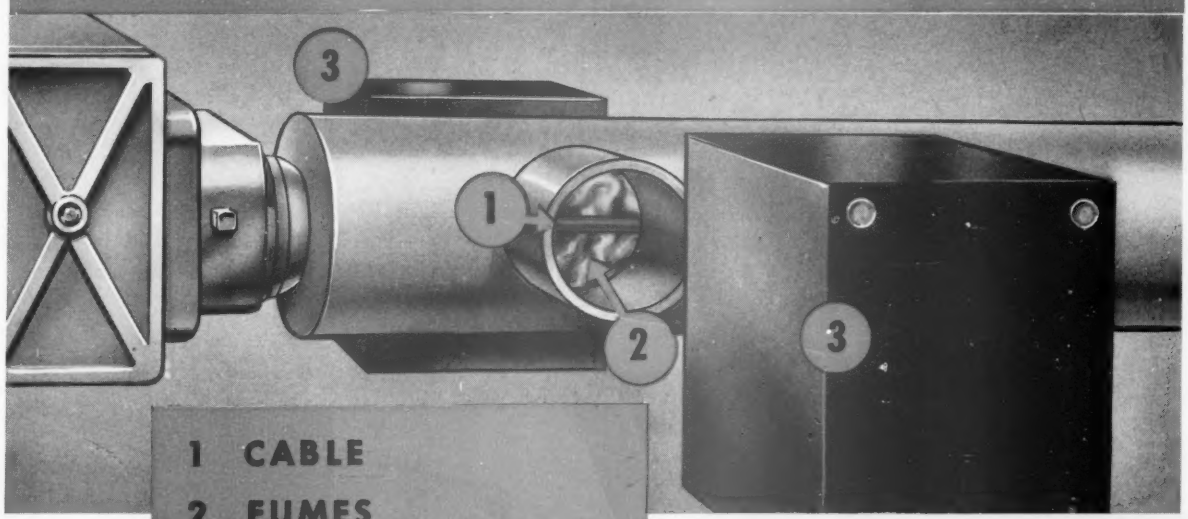

1 CABLE
2 FUMES
3 Serc VULCANTROL

You can put a window in your tube, but you can't see your cable for the Fumes.

The SERC VULCANTROL Can—

You know the cable is there but you can't measure it because you can't get at it.

The SERC VULCANTROL Can—

guarantee to measure and control the diameter of your cable inside the vulcanizing tube, directly after the extruder despite wide differences in light intensities, and save you time and material right now just when time and material conservation are most important.

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LITERATURE, NOW ⇨

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BE THE ONLY ONE.

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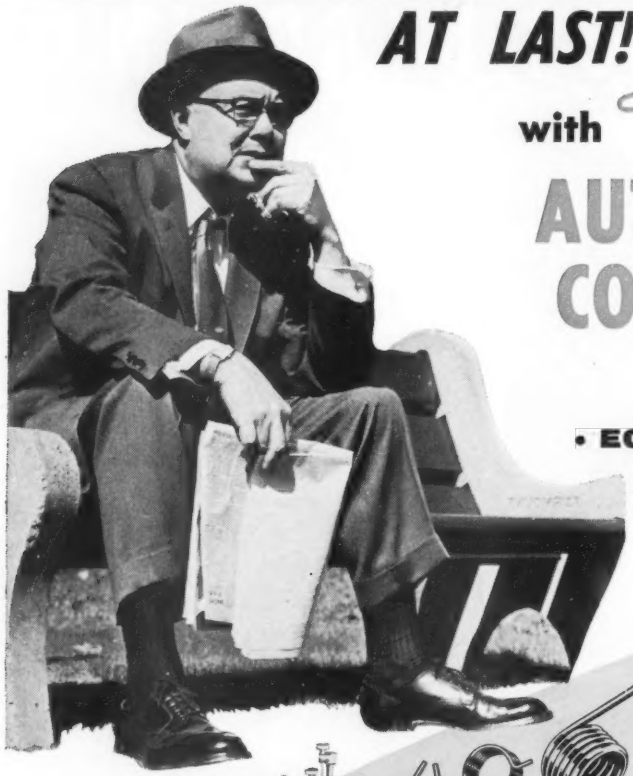
Thinking Of Purchasing A Spring Coiling Machine?

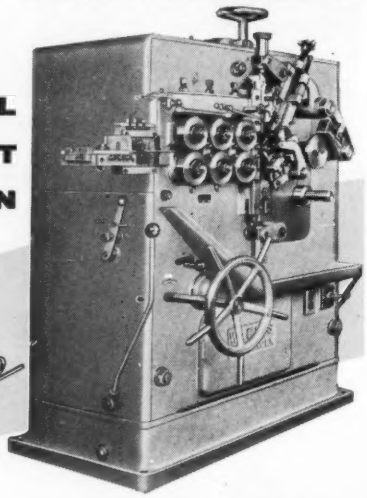
AT LAST! FULL AUTOMATION

with *Wafios* MODEL FM

AUTOMATIC SPRING COILING MACHINES



- ECONOMICAL
- EFFICIENT
- MODERN



This machine is unequalled for high production capacity, exact infinitely variable wire length regulation, and quiet operation. It is capable of handling different wire feed speeds. Almost all compression and tension springs can be mass produced with the F M series. There are five types available; — FM 4, FM 8, FM 15, FM 30, and FM 50. Capable of handling wire with diameters ranging from .004" to .197".

Complete specification bulletins are now available on the Model FM. The SFMU Universal Torsion Spring Coiling Automatic and the Series ZO Automatic Extension Spring Coiling & Looping Machine, and many others, are now available for each series.

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WAFIOS
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335 HUDSON STREET
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THINKING ABOUT WIRE WEAVING LOOMS?

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ROUND MESH and DIAMOND MESH LOOMS
for
FIRE SCREENS, CONVEYOR BELTS, FISH NETS, etc.

CHAIN LINK FENCE LOOMS

HEXAGON MESH LOOMS
for
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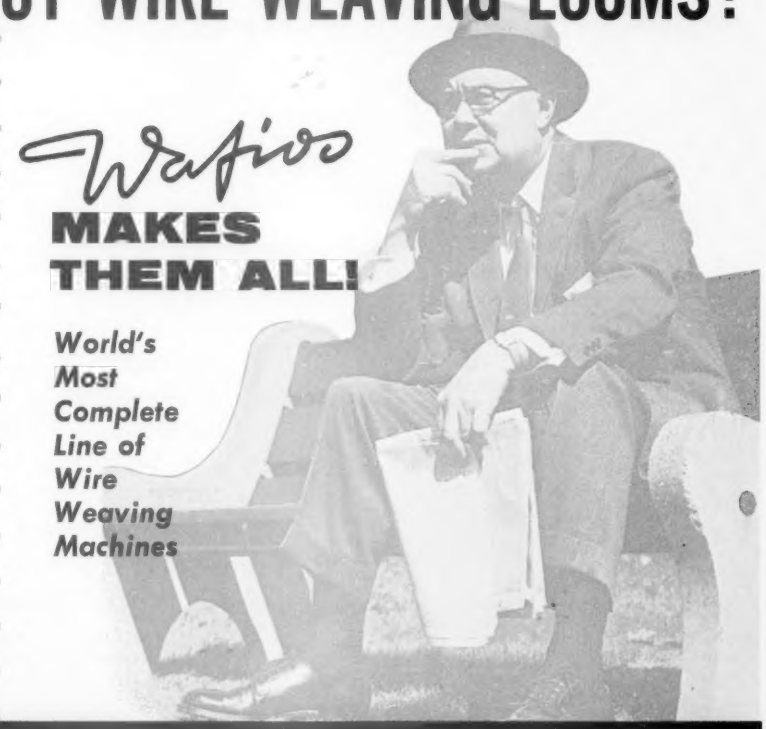

Wafios
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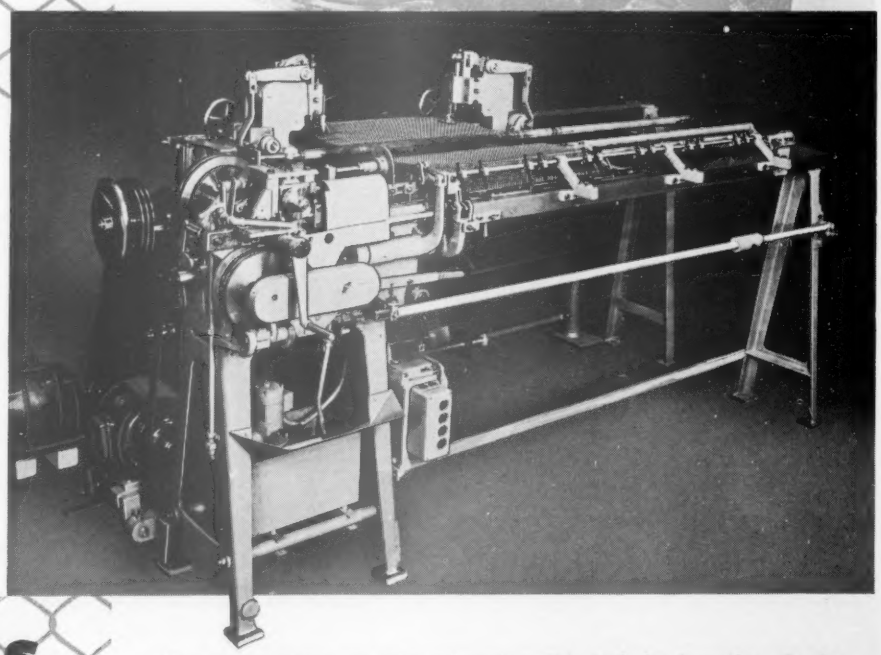
World's Most Complete Line of Wire Weaving Machines



MODEL "RFA"

The fully automatic **ROUND MESH WEAVING LOOM "RFA"** is designed for right or left hand weaving of fire screen mesh in widths up to 6'6". 1, 2 or 3 ply mesh can be produced on this machine.

All operating steps are fully automatic. This includes insertion of reinforcing spirals in repetitive sequence, and knuckling of ends on both sides. The machine is controlled by an electrical stop mechanism cutting out automatically in case of trouble encountered in the wire feed or in the netting tube.
With the machine running continuously, producing a double ply mesh, using wire of 20 gauge with a spiral ∅ of 5/16" and a pitch of approx. 9/16", the hourly production is 110 lbs.

WRITE FOR CATALOG AND COMPLETE INFORMATION

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MACHINERY CORP.
335 HUDSON STREET
HACKENSACK, NEW JERSEY

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Film Insulations: Enamel, EZ-Sol (nylon), Hud-Sol (polyurethane), Formvar, Siliclad (silicone), Nyform, Nypoly, Isonel & ML (220°C), each single or heavy. Sizes 14 to 56. Fabric Insulations: Celanese, Nylon, Silk, Cotton & Orlon, each single or double. All solid & tracer colors, Sizes AWG 20 and finer. Combinations of Film & Fabric insulations available.

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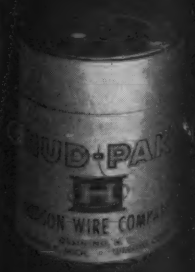
SINGLE END and STRANDED BARE CONDUCTORS

Copper (ETP & OFHC), Brasses, Bronzes, Other Copper Alloys, Aluminum, Silver, Zinc, Cadmium, Nickel, Tin, Lead, Monel, Stainless Steel, and Copper Coated Steel. Most metals available plated with Silver, Nickel, Tin (Hot Dip & Electro), Tin-Lead Alloys and Gold.

Concentric, Unilay, Bunched, and Rope Stranding, regular and reinforced, in finished Sizes AWG 4 to 32.

FINE WIRE AT ITS FINEST

Available on Standard Wire Spools
and on the Exclusive
HUD-PAK*
High Speed Wire
Payoff Package



FEATURING:
- High Speed Payoff in excess of 500 ft. per. min.
- Controllable Tensions.
- Large Payoff Packages of 50 and 120 Pounds.
- Instantaneous Starts and Stops.
- Rugged Construction to Protect Wire in Use or Storage.

(Cut-away View)

*The terms "Hud-Pak" and "De-Paker" are trademarks of Hudson Wire Co.

Phone or Write Hudson NOW for spec quotes and technical assistance

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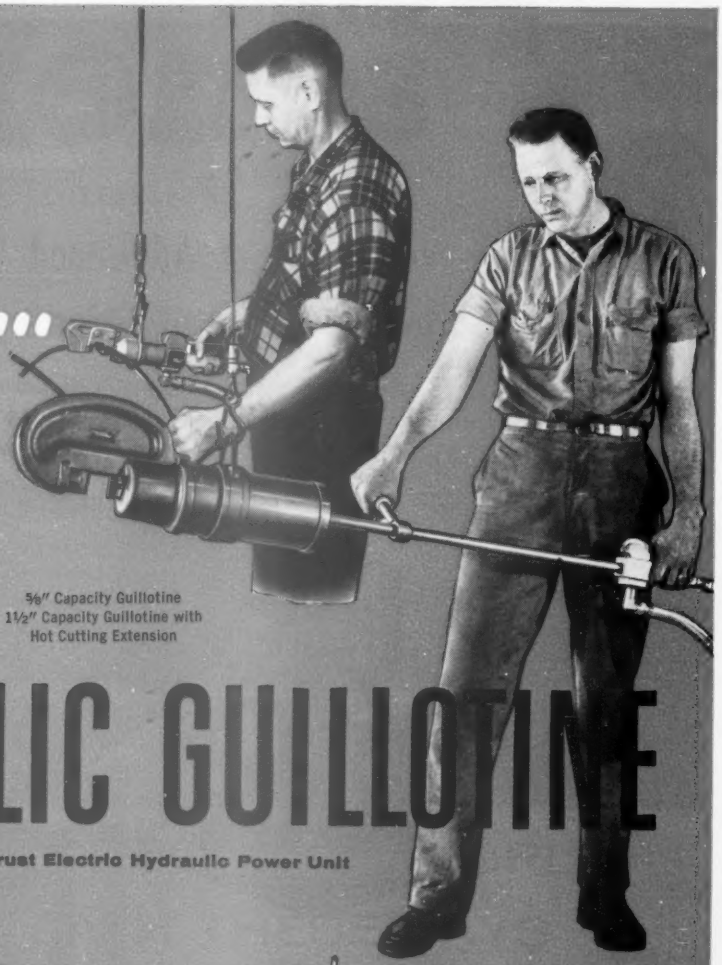
Fastest, Lowest Cost...

METHOD FOR CUTTING WIRE AND ROD



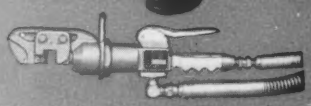
⅝" Capacity Guillotine
1½" Capacity Guillotine with Hot Cutting Extension

MANCO HYDRAULIC GUILLOTINE

Powered by Manco Hi-Thrust Electric Hydraulic Power Unit

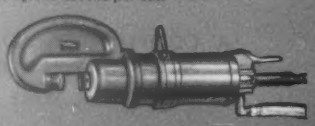
ENGINEERED FOR MINIMUM MAINTENANCE

These are completely re-engineered and redesigned versions of the famous Manco Hydraulic Guillotines used by virtually all major rod mills throughout the world. These new units provide even greater performance . . . and require an absolute minimum of maintenance. It is also possible now to operate two cutter heads off one power unit, either by using the new Manco HA-2 Hi Thrust power unit, or by adding the new Manco Auto-Selector Valve to present Manco power units.

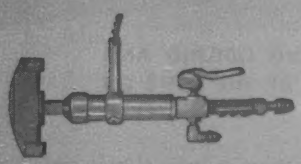


Model MC 210: Capacity ⅝". High speed . . . ½ second per cut. Full swivel action.

Model MC 35 HD: Capacity 1⅛". Cuts high carbon material including reinforcing rod in only one second per cut.



Model MC 65 HD: Capacity 1½". Cuts 1½" diameter steel in 2 seconds per cut. Can be modified to cut 1¾" diameter aluminum.



MANCO HYDRAULIC ROD STRAIGHTENER

Ideal for straightening leading end of heavy coiled wire for insertion into drawing dies and cold heading machines. Capacity of ⅜" to 1¼" diameter steel rod.

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MANCO MFG. CO., Bradley, Illinois
Dept. No. W-10

Please send:
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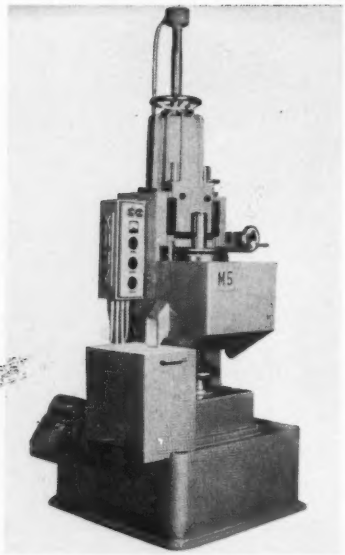
Presents

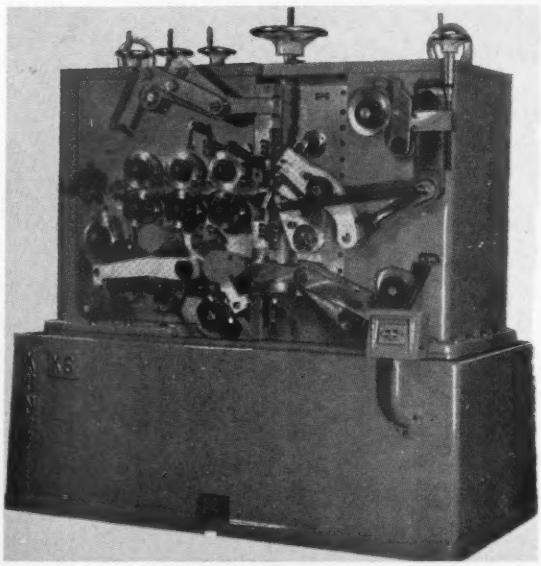
World's Most Advanced Universal Spring Coiling and Grinding Machines



Model M5 Spring End Grinding Machine

SPECIAL FEATURES:

Maximum stability and simplicity of operation. Extremely rapid changing of the grinding wheels is insured by the easy accessibility after swinging back the upper grinding spindle assembly (patented).



Model K6 Universal Spring Coiling Machine

SPECIAL FEATURES:

Completely enclosed box construction and oil bath lubrication. All five cams required for universal spring production are located on the front of the machine. Easy setting-up is insured by the neatly grouped arrangement of the controls on the front of the machine.

Only ball and needle bearings are used (no bronze bushings). Patented control of the ejector fingers.

A COMPLETE LINE OF UNIVERSAL SPRING COILING AND GRINDING MACHINES, MANUFACTURED BY THE KUNZ CO. IN ITALY, FOR WIRE UP TO .590" DIA.

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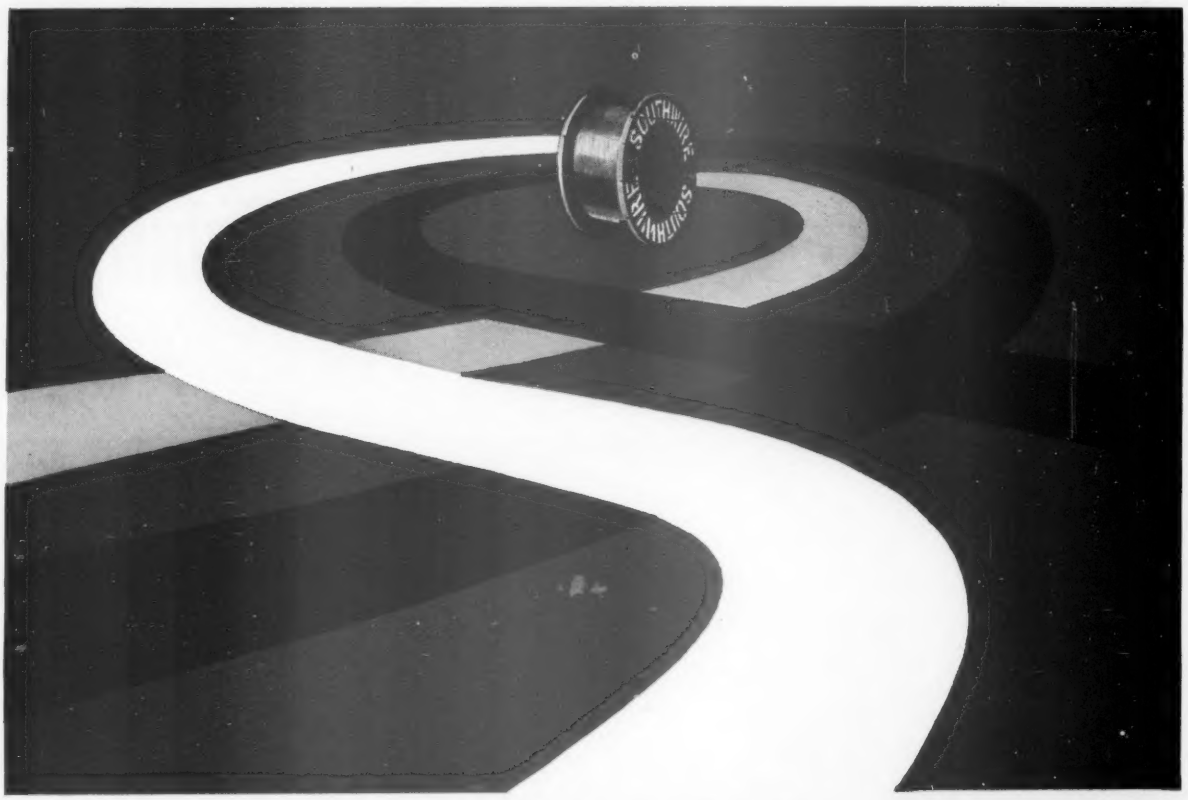

YOU CAN'T WAIT FOR THE WORLD TO BEAT A PATH THESE DAYS

"If a man can make a better mousetrap than his neighbor, though he builds his house in the woods, the world will make a beaten path to his door."

With respect to Ralph Waldo Emerson, competition being what it is in the twentieth century, Southwire has pressed his advice a step further. We have not only endeavored to make better products, but we have also succeeded in . . .

- Operating the industry's largest fleet of trucks for fast delivery to customers' warehouses and jobsites.
- Maintaining flexible manufacturing schedules to meet needs of customers on short notice.
- Pioneering continuous aluminum casting.
- Developing the first 11,000-pound coil of aluminum rod.
- Developing new products through basic research—including 100% free-stripping Neoprene.
- Acquiring a list of loyal customers, of whom we are justly proud.

That our customers have benefited from these achievements is borne out of their use of Southwire products and the consequent growth of our company, which is 25 times larger today than ten years ago.

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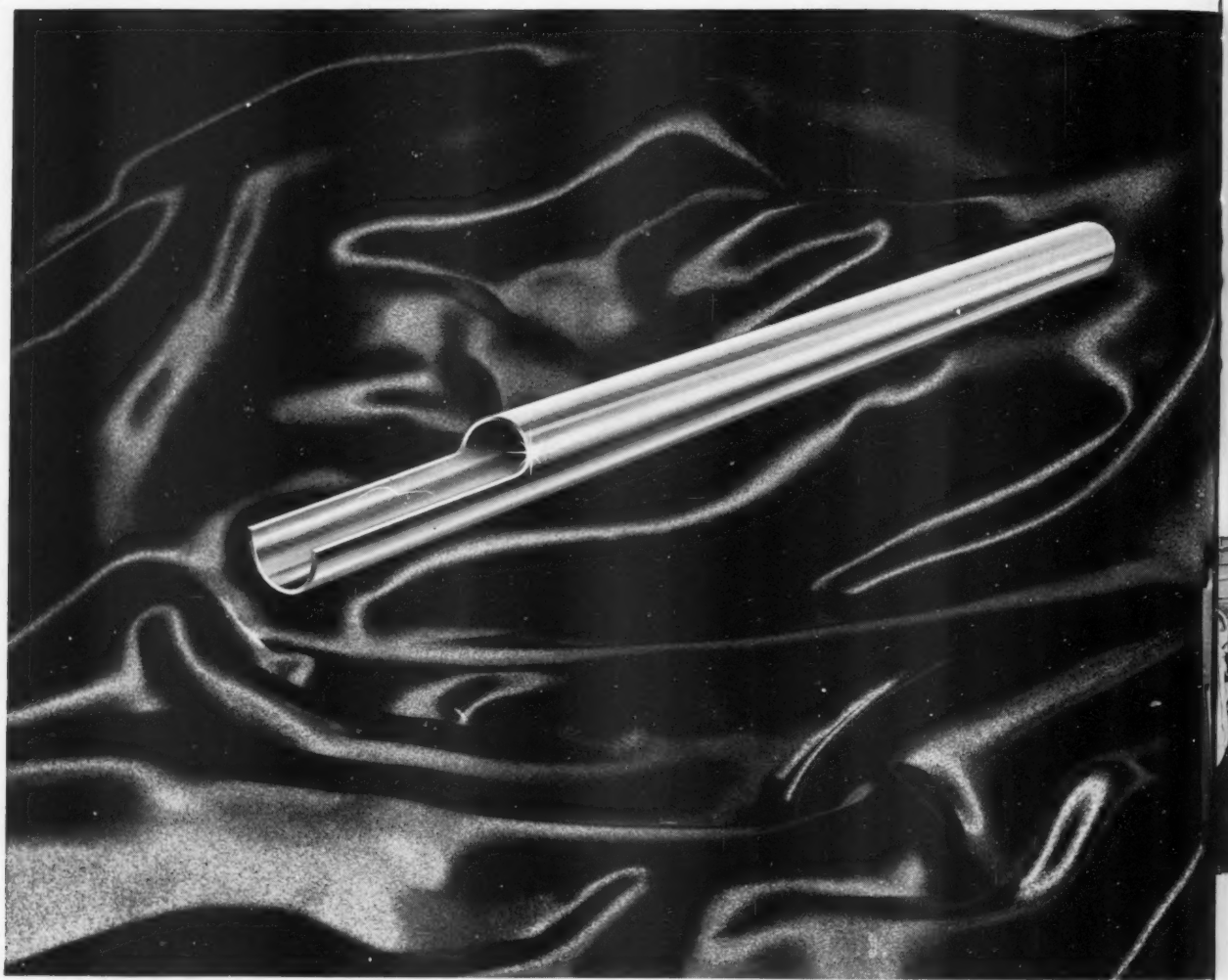
AMCHEM GRANODRAW SS* No. 16 Finish of Stainless Steel Tubing at



Consistent attention to quality production is rapidly achieving a reputation as the "Tiffany of the industry" for Summerill Stainless Tubing. Amchem's Granodraw SS No. 16 is an integral part of the quality story that has created favorable impact for this far-sighted industry leader.

Improves Drawability and Surface Summerill Stainless Tube Division

New Granodraw SS No. 16 Oxalate Coating Operates More Efficiently Regardless of Pre-Treatment

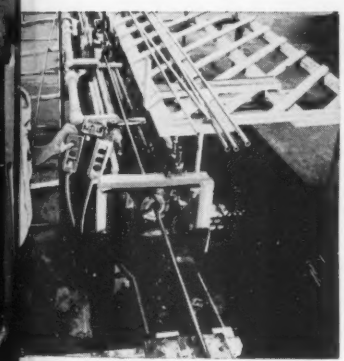
At Summerill Stainless Tube Division of Columbia Steel & Shafting Company introduction of a new Amchem Granodraw SS coating has greatly increased tube drawing efficiency and improved the quality of Summerill's tube surfaces. Summerill, well known for smooth, low micro-inch I.D., mandrel drawn and bright annealed surfaces makes strong demands on coating and drawing compounds.

In operation only a short time the Granodraw SS No. 16 process is virtually paying for itself in reduced scrap loss—the result of its amazing adaptability to operate efficiently regardless of the pre-treatment or pickling process involved prior to coating. Proof of performance, too, is the fact that Granodraw SS No. 16 operations at Summerill have resulted in substantial reduction in competitive chemical costs—with improved drawability and I.D. and O.D. quality.

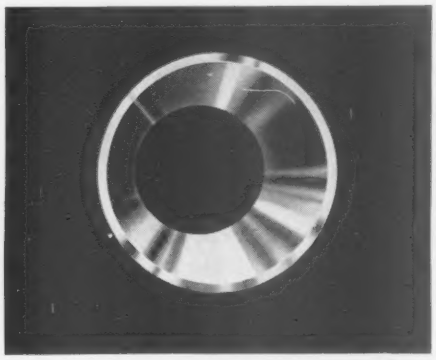
Built-in features of Granodraw SS No. 16 also accrue to Summerill's advantage—chloride and fluoride free coating, easily controlled two (2) chemical process which consistently produces an exceptional I.D. and O.D. finish that meets the most critical standards in the tube drawing industry.

If you draw, extrude or cold form stainless steel, you should investigate the operational advantages and end product benefits of Granodraw SS No. 16. Your local Amchem Representative is as near as the telephone!

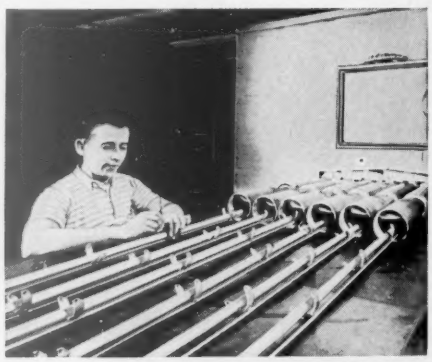
*Amchem's registered trademark for its conversion coating chemical for stainless steel.



Mandrel drawing at Summerill. This method of cold-reduction produces the fine finishes and exact tolerances found in every Summerill tube.



The exceptionally bright finish achieved on Summerill Stainless Tubing is often referred to as "The New Look Inside."



Summerill Stainless Tubing entering the bright-annealing furnace. Note the brightness even before bright-annealing.

AMCHEM

GRANODRAW SS No. 16

Amchem and Granodraw are registered trademarks of
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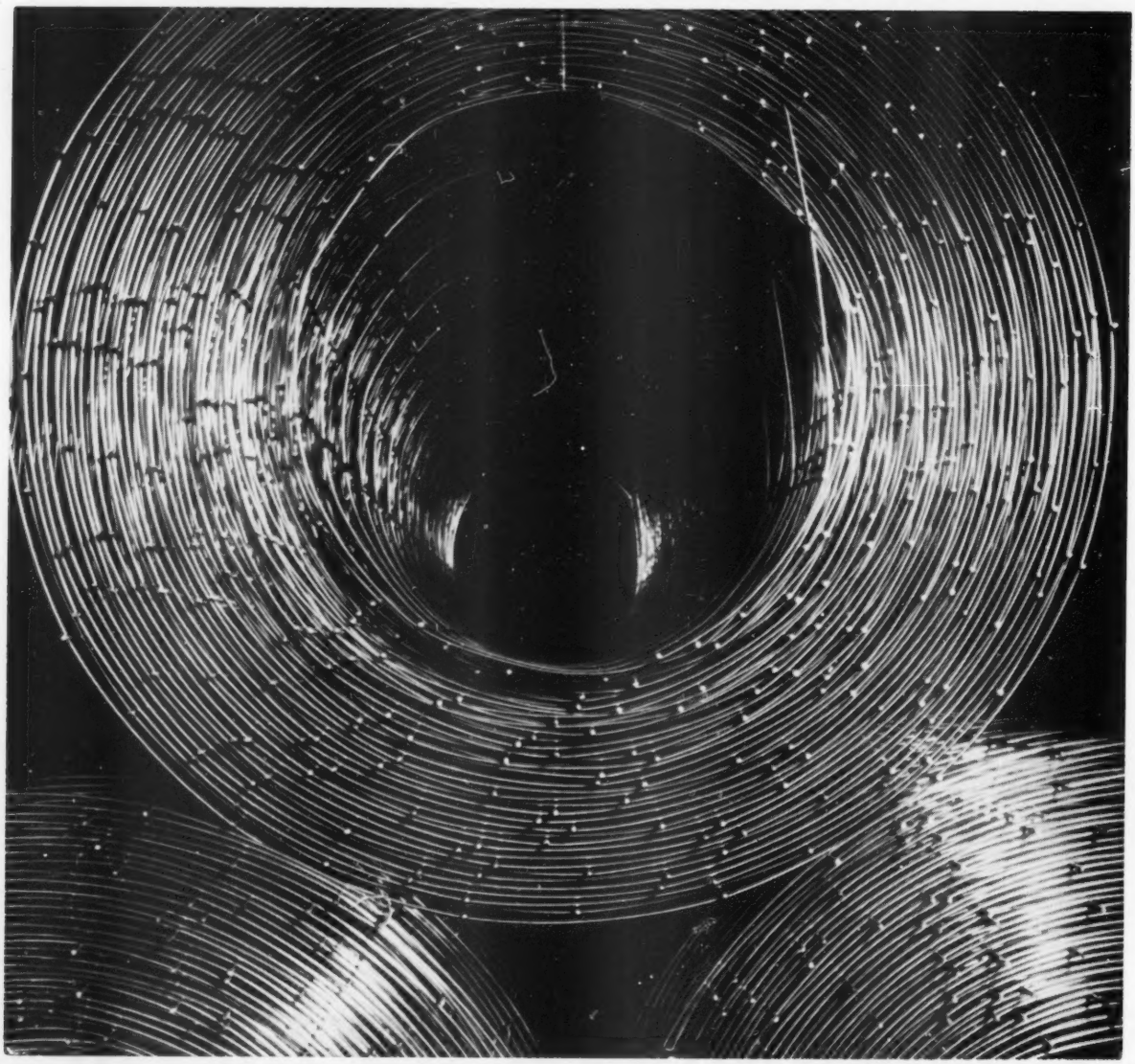
We have been specialising in the construction of resistance welding machines for nearly half a century. Fifteen years ago we produced the first mesh welding plant. This long experience has been utilised in the development of our modern mesh welding plants, and our manufacturing programme now includes a comprehensive range of machines.

Model 1 for light mesh in rolls and sheets	Wire 0.06—0.16 inch dia., width 79 inch.
Model 2 for mild steel mesh in rolls	Wire 0.12—0.24 inch dia., width 104 inch.
for mild steel mesh in sheets	Wire 0.12—0.39 inch dia., width 104 inch.
Model 3 for mild steel mesh in rolls	Wire 0.12—0.24 inch dia., width 147 inch.
for mild steel mesh in sheets	Wire 0.12—0.39 inch dia., width 147 inch.
Model 4 for mild steel mesh in sheets	Wire 0.16—0.47 inch dia., width 147 inch.
Model 5 for heavy mild steel mesh in sheets	Wire 0.16—0.47 inch dia., width 104 inch.



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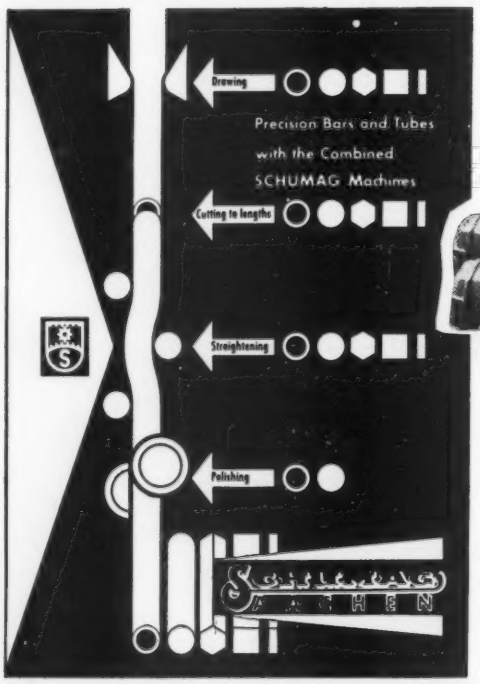

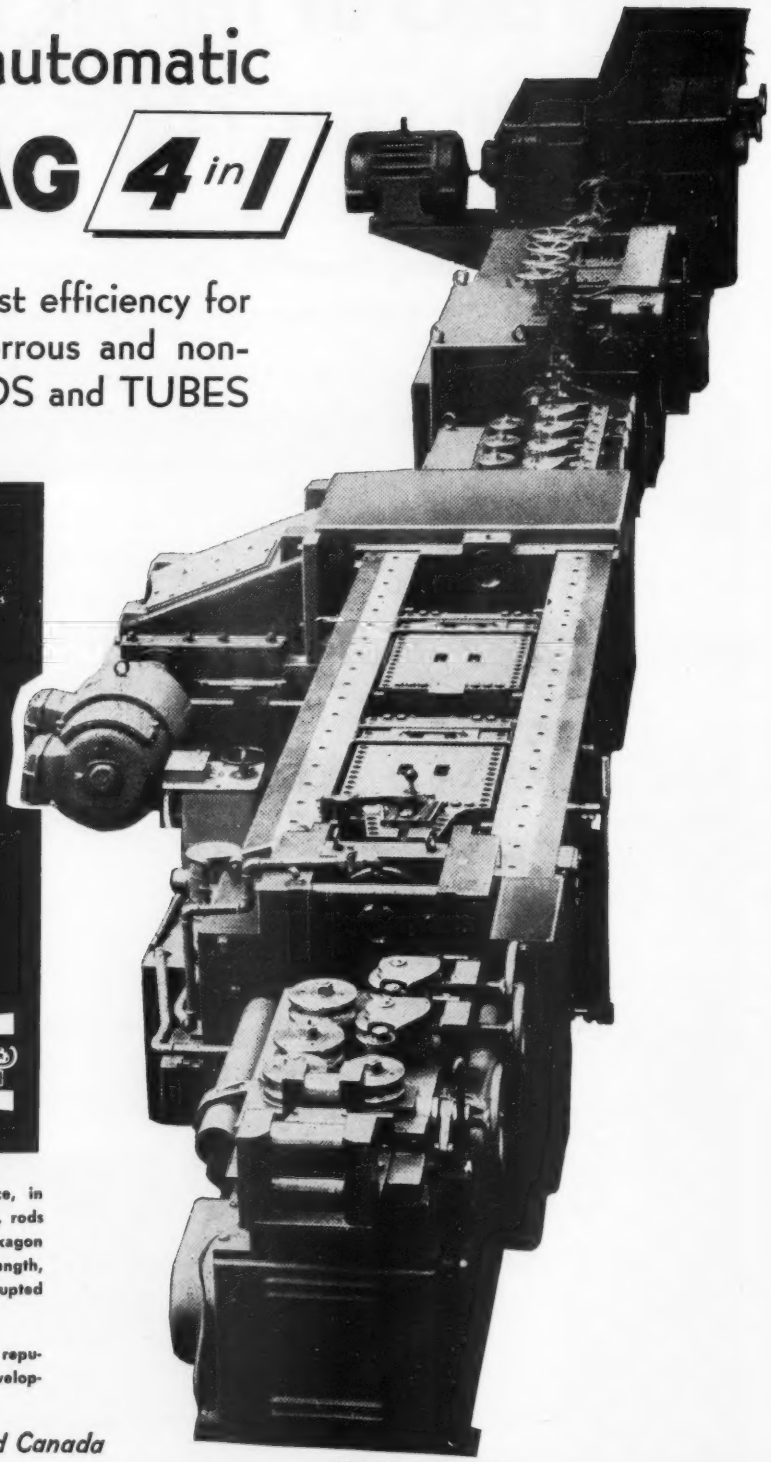

- SCHUMAG "4 in 1" machines produce, in one continuous operation, finished bars, rods and tubes from round, square or hexagon material. They will finish draw, cut-to length, straighten and polish in one uninterrupted sequence.
- SCHUMAG "4 in 1" enjoys world-wide reputation as the ultimate in technical development.

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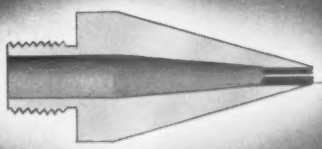
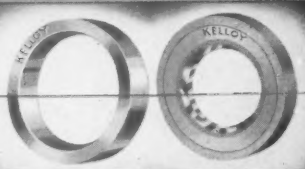
Specify "KELLOY" CARBIDE SHAPE DIES



CARBIDE TIPPED GUIDE FOR INSULATING WIRE & CABLE SINGLE OR MULTIPLE HOLES



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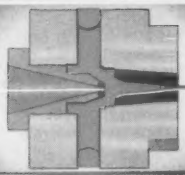
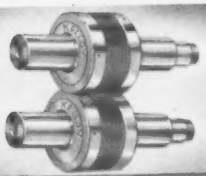
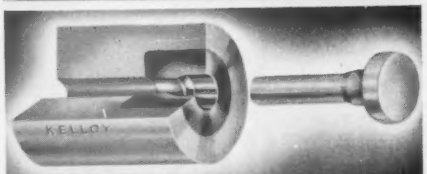


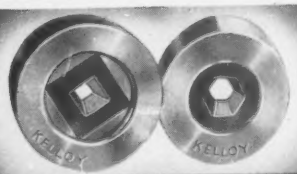
SELF ALIGNMENT PRECISION HEAD & EXTRUDING TOOLS FOR EXCHANGE CABLE INSULATING



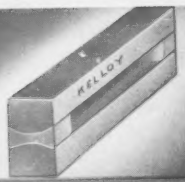
WIRE FLATTENING ROLLS. TRUE SURFACE FOR HIGH QUALITY FLAT WIRE.



BOLT SIZING DIES. COMPLETE AND READY TO USE. CLOSE TOLERANCES.



SHAPE DIES WITH SHARP TRUE CORNERS FOR ACCURATE PRODUCTION.

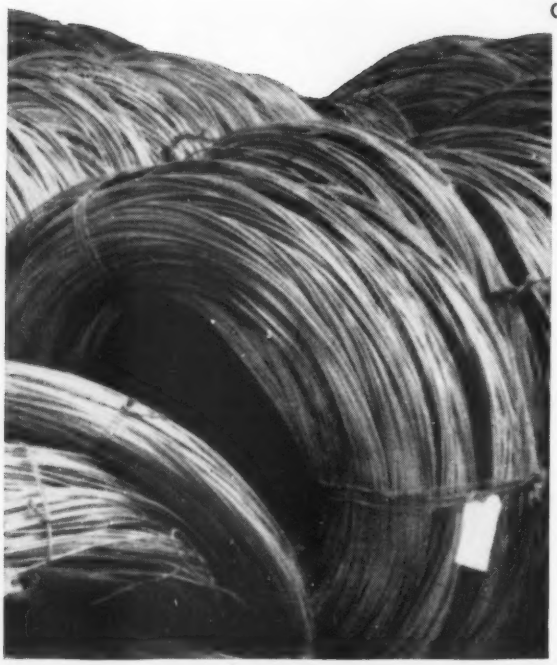


SIDE AND END BLOCKS. COLLAPSIBLE DIES FOR DRAWING BAR STOCK.

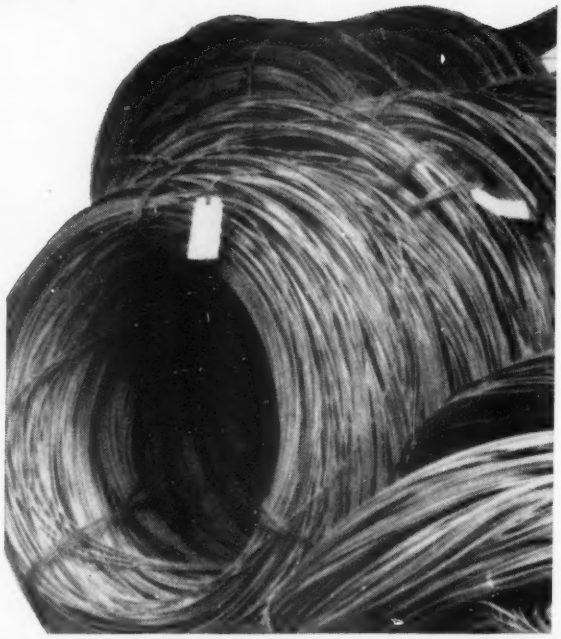
KELLOY CORPORATION
NEW YORK 1, N.Y.

Operation: Descaling

(One of a series)



Drawn and annealed wire descaled up to 800 feet per minute



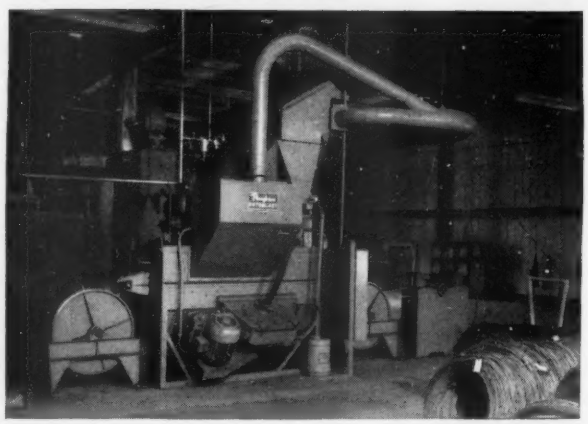
Hot rolled rod descaled at 200-600 feet per minute

These figures speak for themselves!

Compare these speeds with your own descaling performance. Then consider this: fast descaling time is only one of many reasons why Pangborn Rotoblast cuts your costs.

Here are some other specifics: Rotoblast eliminates loss of virgin metal . . . ends acid disposal problems . . . requires less space . . . reduces original investment by as much as 70% over pickling equipment. Rotoblast descaling equipment goes to work at the touch of a button. Because it is a dry process, it is absolutely non-toxic, an important aid to employee morale. Rotoblasting gives an improved surface for application of lubricant.

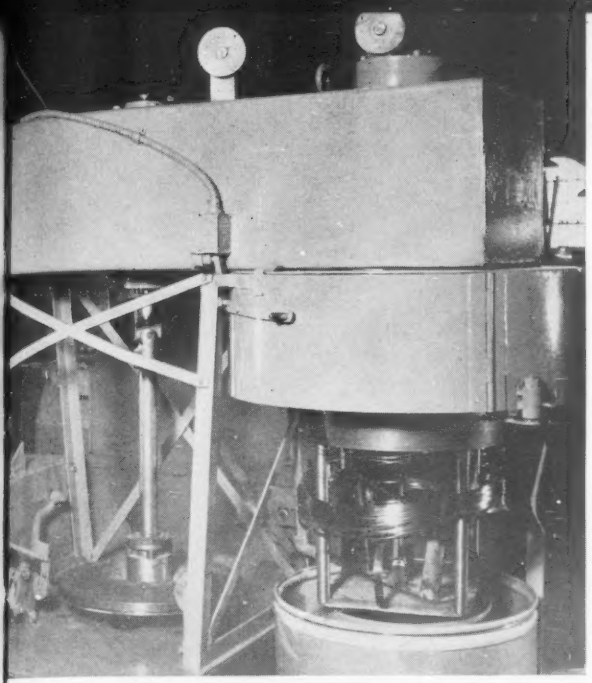
You save money other ways, too. You can maintain Rotoblast more easily. Because Rotoblast Cabinets are fully lined with wear plates, you never have to replace the cabinets themselves. All three wheels of the Rotoblast units assembly are fully exposed and easily accessible—not locked up inside the equipment. Overall result: lower operating costs, lower maintenance costs.



Pangborn

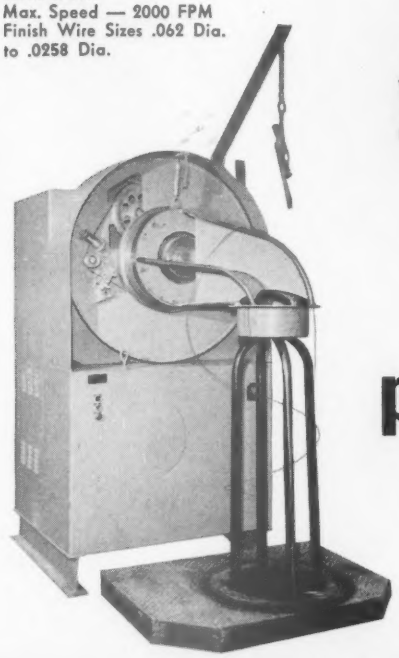
OF HAGERSTOWN

For more detailed information, write: PANGBORN CORPORATION, 5400 Pangborn Blvd., Hagerstown, Md.; Pangborn Canada, Ltd., 47 Shaft Rd., Toronto (Rexdale), Canada—*Manufacturers of Blast Cleaning, Vibratory Finishing, Dust Control Equipment; Rotoblast® Steel Shot and Grit©.*



CONTINUOUS OPERATION ATTACHMENT
Fine wire dead block drawing attachment (adaptable to most standard machines) permits continuous operation.

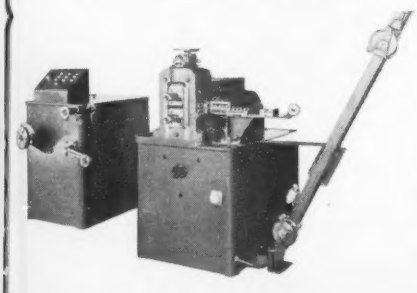
Wet Machine
Dead Block Attachment
Direct Drive
Max. Speed — 2000 FPM
Finish Wire Sizes .062 Dia.
to .0258 Dia.



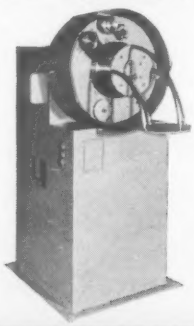
for all your wire drawing and processing needs

Coarse Wire Dead Block Attachment
AC, DC or Direct Drive
Max. Speed — 1600 FPM
Finish Wire Sizes .090 Dia. to .062 Dia.

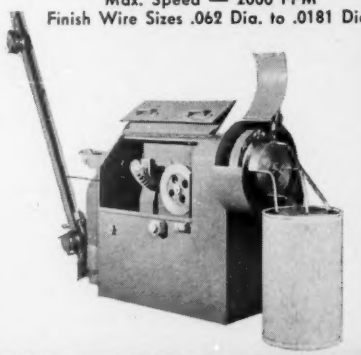
6" Diameter Rolling Mill
AC, DC or Hydraulic Drive
Max. Speed — 1800 FPM
Max. Entering Wire Size .150 Dia.



Fine Wire Dead Block (Motorized)
AC, DC or Hydraulic Drive
Max. Speed — 1800 FPM
Finish Wire Sizes .062 Dia. to .0181 Dia.



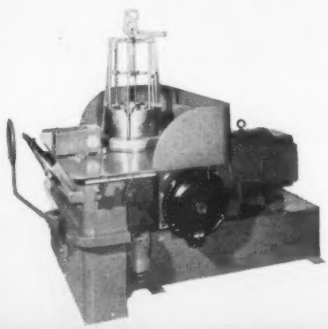
Dead Block Wet Drawing Machine
AC, DC or Hydraulic Drive
Max. Speed — 2000 FPM
Finish Wire Sizes .062 Dia. to .0181 Dia.



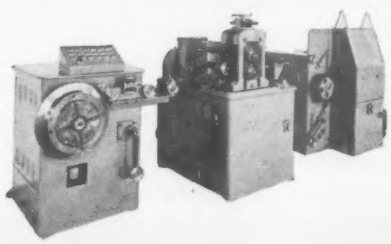
a complete service:

Machine design, production planning, plant layout, installation, pilot operation.

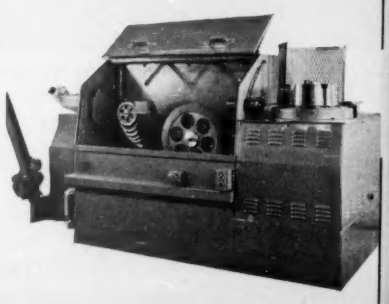
Single Hole Motorized Block (Wet or Dry)
AC or DC Drive — Max. Speed — 900 FPM
Finished Wire Sizes .125 Dia. to .062 Dia.



Combination Draw - Roll - Spool
AC, DC or Hydraulic Drive
Max. Speed — 1800 FPM
Max. Entering Wire Size .090 Dia.



Wet Drawing Machine
AC, DC or Hydraulic Drive
Max. Speed — 2000 FPM
Finish Wire Sizes .062 Dia. to .0258 Dia.



Manufacturers of Standard and Custom Designed Wire Drawing and Wire Processing Machinery

WIRE ENGINEERING ASSOCIATES, INC.

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REPRESENTATIVES: Midwest—Bronson & Bratton, Inc., 5161 S. Millard Ave., Chicago 32, Ill.—Phone Reliance 5-6200

Nelco coated wire stands up to the elements

What's the "hidden ingredient" you look for in a lacquer? It's the organization behind it. Research. Testing facilities. Pilot plant runs. Production capacity. And of course experience.

That's what makes Nelco lacquers the *lacquers with a difference.* They're not just "mixed" — they're carefully *formulated* to make certain they'll meet your strictest specifications.

Of our hundreds of stock formulations for wire and cable coating, we've listed a few here. With our unique facilities we can *custom* formulate still others to meet special requirements.

Send for the Nelco Data Book. You'll have facts — at your fingertips — for every construction. Or send us information on your coating problems.

Look at this array of lacquers. High temperature resistant. Clear, glossy film. Flame retardant. Fray prevention. MIL spec. finishes. Fungus resistant.

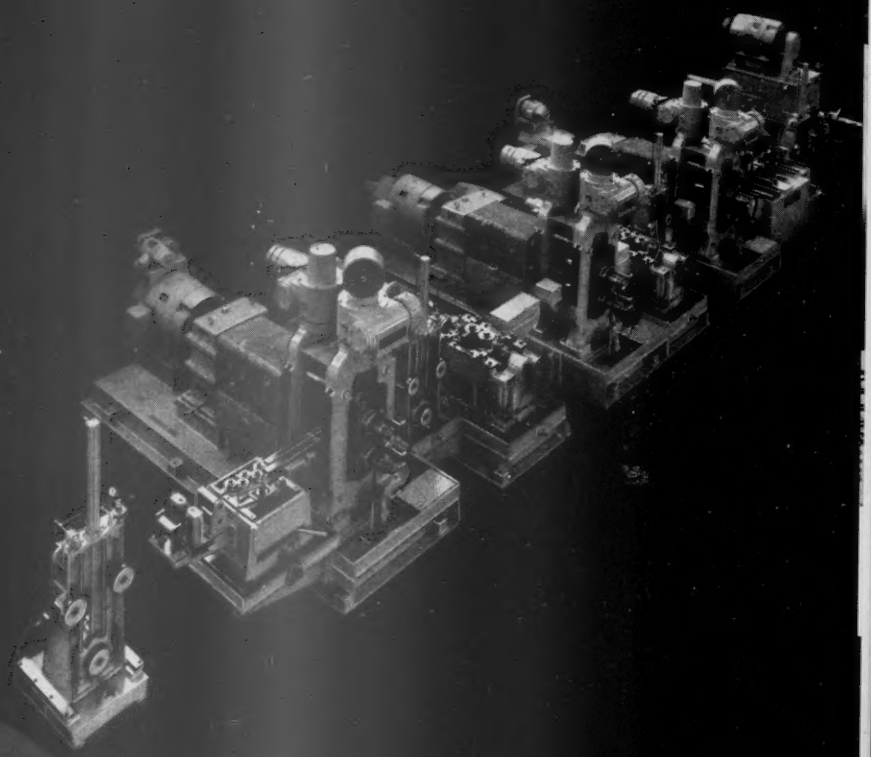
NL 7147 Nelco Clear Cable Coating
NL 8223 Nelco Clear Heat Resistant Cable Coating
NL 9731 Nelco Flame Retardant Saturant
NL 8211 Nelco Moisture Resistant Saturant
NL 9776 Nelco Clear Cellulose Acetate Cable Coating
R 4026 Nelco High Temperature Resistant Cable Coating
R 5979 Nelco Clear Nylon Cable Coating
R 6625 Nelco Ribbon Cable Adhesive

Back of Nelco lacquers are 40 years experience serving the wire and cable industry.

Nelco LACQUERS

Not just mixed ... they're formulated

NELCO LACQUER DIVISION, **CHEMICAL PRODUCTS CORPORATION**, EAST PROVIDENCE, RHODE ISLAND



HIGHER SPEEDS

INCREASED POWER

GREATER FLEXIBILITY

= LOWER WIRE FLATTENING COSTS

Torrington Flat Wire Mill lines are built with new dimensions of ruggedness, precision, and operator control. From starting round to finished flat speeds can be as high as 3500 FPM with tolerances of plus or minus .00025″ in thickness and .0005″ in width. This entire operation is controlled from a central station. *Torrington's method means more finished wire in less passes and anneals between the round and the finished flat.* The engineers who designed this equipment will study your specific requirements and make recommendations. For lower wire flattening costs write to Torrington now.

TORRINGTON
MANUFACTURING COMPANY
MACHINE DIVISION, TORRINGTON, CONNECTICUT

An automatic coiler forms .063 Johnson tinned music spring wire into an automobile brake cylinder spring. Because this spring will spend its life in a bath of corrosive brake fluid it needs a heavy, uniform tin plating that will not peel, crack or flake. It is a critical spring with 12½ coils, held to tight tolerances and coiled with two different end sizes. The larger end is 1.034 inches while the smaller end is .710 inch.

Mid-Continent Spring Company of Ky. says . . .

Dependable Johnson Music Spring Wire Gives Precision Springs Reliability

Dependable quality and quick service are two major reasons Johnson wire is specified in Kentucky spring plant

"After 23 years in the spring manufacturing business, I'll give you my one-word description of Johnson Steel & Wire Company's spring wire . . .

"It's DEPENDABLE."

So says L. B. Langhi, president of Mid-Continent Spring Company of Ky.

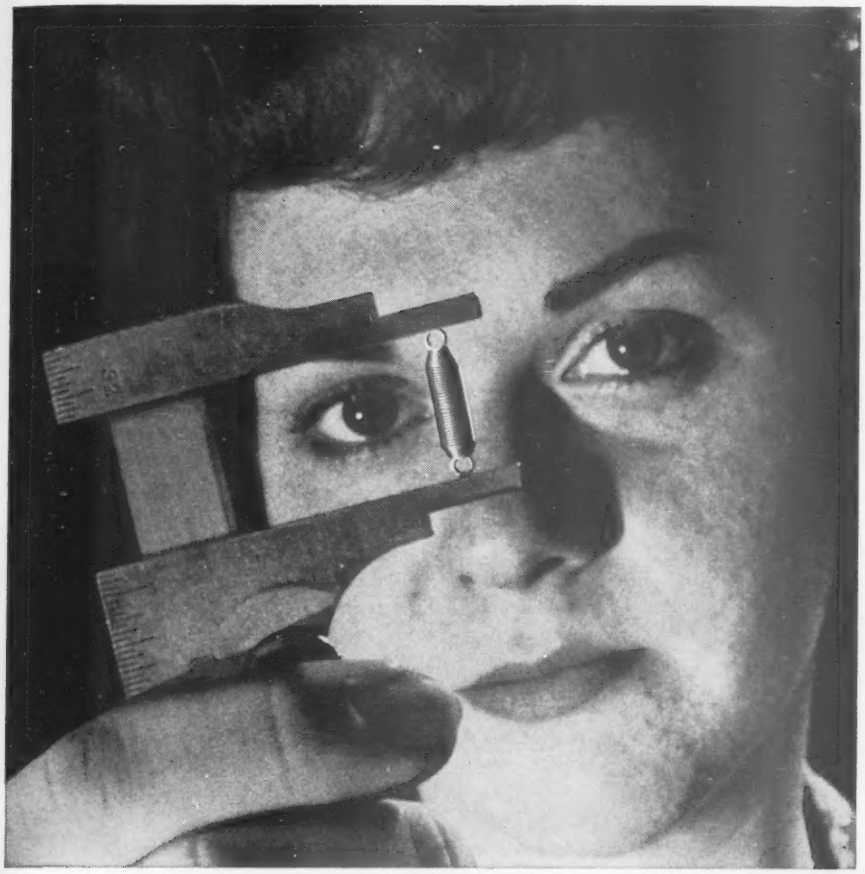
And that goes for Johnson's high carbon wire destined for springs that snap into action at the critical moment of a missile launching or simply make a baby doll wink, as Mr. Langhi explains.

Regardless of their job, it's vitally important to Mid-Continent's customers that springs function with precision. So the firm's plant at Hopkinsville, Ky., builds reliability into all its products, whether for space flights, toys, automotive and electrical parts or vending machines.

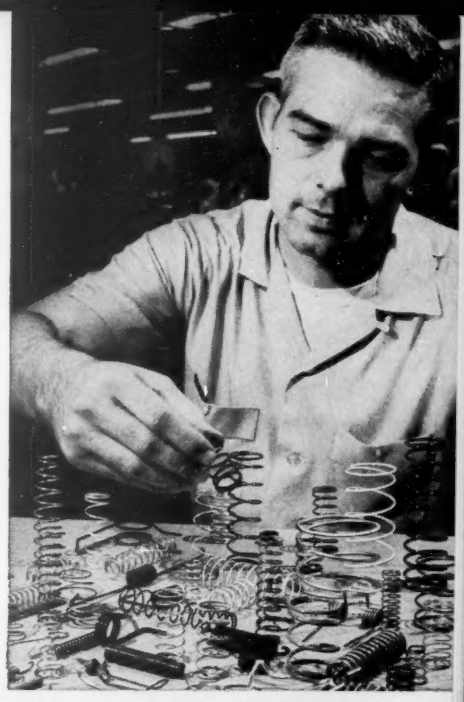
This reliability depends as much upon the raw materials of the springs —music spring wire or oil tempered spring wire—as it does upon the skills of Mid-Continent's spring makers.

Mr. Langhi said: "Because our customers depend upon our springs to give them a full measure of value, we demand and get wire from Johnson that has a uniform quality in finish, temper, size and physical properties.

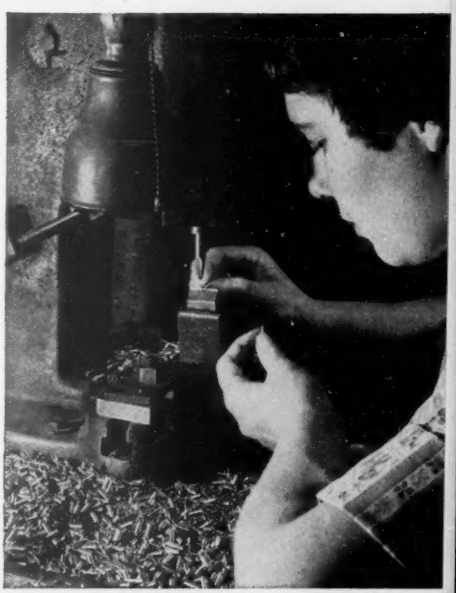
"Coatings on Johnson tin-coated



A carburetor control extension spring must be held to unvarying tolerances to insure consistent performance. This important spring is made of Johnson .010 tinned music spring wire, has an O.D. of .118 inch and measures ¾ inch outside the loops.



R. M. Worthman, purchasing agent for Mid-Continent Spring examines some of the one thousand different type springs manufactured at Mid-Continent.



This tiny vending machine extension spring is made of Johnson .013 tinned music spring wire, has .158 I.D. and 22 turns.

music spring wire are both uniform and adherent. This eliminates peeling, cracking or flaking during our coiling operation."

High physical properties, uniform cast and smooth surfaces are other important requirements since Mid-Continent springs must form within strict dimensions and carry precise work loads.

At Mid-Continent, accuracy of wire dimensions greatly affects spring coiling and performance. Close tolerances on dimensions are met consistently in fine wire specialties produced by Johnson Steel & Wire Company.

"Our production averages over a million springs per day," said R. M. Worthman, purchasing agent for Mid-Continent Spring.

"Because of this, we keep our warehouse stocked with at least 300 tons of wire. Johnson supplies us with a range of .008-inch to .207-inch music spring wire and oil tempered wire.

"Whenever our wire stock begins to deplete, we're able to call for and get fast delivery service from Johnson's mill in Worcester or from its warehouses in Chicago or Akron.

"Of the 64 different types of brake drum springs we manufacture, 90 percent of them are made of Johnson wire. That's what we think of Johnson Steel's wire."

Let Johnson start today to help you with your high carbon spring wire needs.

Just call the nearest district sales office and talk with a Johnson representative. He's ready to help you with whatever your wire and spring problems might be—right now.

Johnson Steel & Wire Company, Inc.

Worcester 1, Massachusetts

a subsidiary of **Pittsburgh Steel Company**

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Steel

Where wire men meet...

talk turns to Apco Mossberg

Wherever wire and wire rope handling problems are discussed — at high level conferences or on production lines — men mention Apco Mossberg in the same breath with steel reels, spools and bobbins. And for good reasons.

Reasons such as Apco's staff of engineers. These are men long experienced in the ways of efficient wire drawing, reeling and spooling. Men with proven ability to come up with practical solutions . . . answers which often pay off in substantial production and shipping economies. Then, too, there are the men behind the men . . . skilled craftsmen working with modern, high speed production facilities to bring you custom engineered units in any size or design.

Together these wire-wise men can make short work of your toughest handling problem. Try them and see at your earliest opportunity.

SEE OUR MEN
at the
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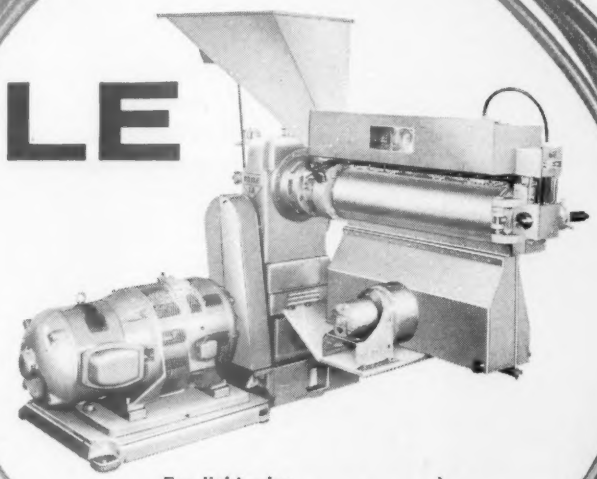
FOR ALL YOUR INSULATED WIRE PRODUCTION NEEDS...

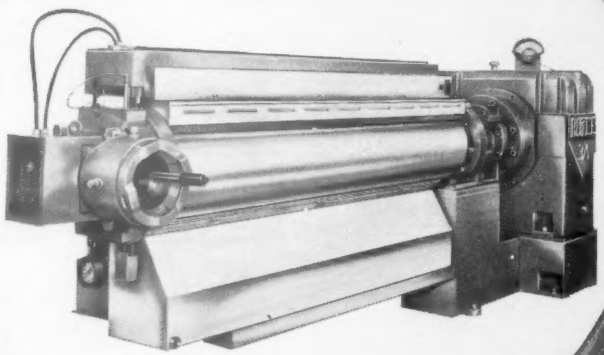
Choose ROYLE

Royle has the **completely engineered** extruder and auxiliary equipment exactly suited for your insulated wire production needs . . . whatever they may be. For day-to-day, fast profitable, production of telephone wire, building wire, high-voltage cable, large diameter cable and specialty wire, specify Royle.

Royle Spirod® Extruders have the heating and cooling capacity to process all of the latest insulating compounds — even the most corrosive.



For light wire
Royle (2½") Spirod Insulating Machine



For Cable
Royle (6") Spirod Jacketing Machine

Royle Auxiliary Equipment includes:

Custom Synchronized Extruder-Capstan Drive Systems
Controlled Cooling Trough Systems
Dry Blend Hopper-Screw Seals
Payoffs
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Like the masters of old ...we in research today must use every facility at our command to achieve a fine standard of products.

A word about the Polymel Collection of Fine Arts

Here at Polymel our life is brightened by our gallery of fine paintings from the talented fingers of the world's renown masters. The one which we have photographed is the priceless work of Vecelli Tiziano. Many others admired by our clients and co-workers include:

Rembrandt, Jordaens, DeWit, Noel, Raphael, Kneller, Reni, Reynolds, Allegretto, Gainsborough, Romney, Horemans, Cluet, Rossetti, Maurice Delatour, G. W. Peale, Alexander Healy, Stuart, F. Waugh, Henry Inman, George Inness, Rembrandt Peale.

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President

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one of the world's largest manufacturers of aluminum wire

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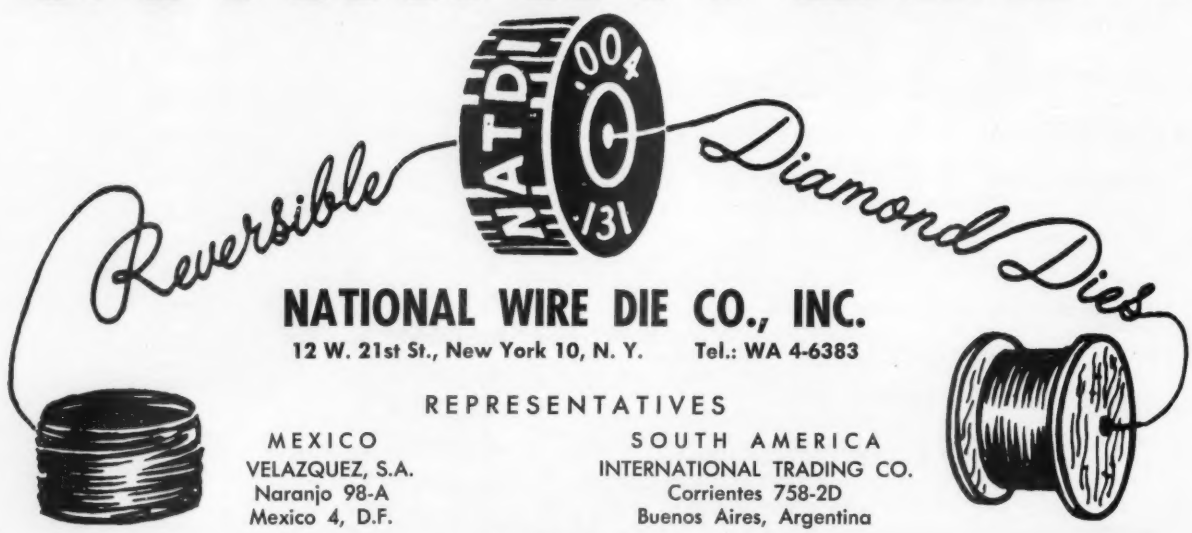

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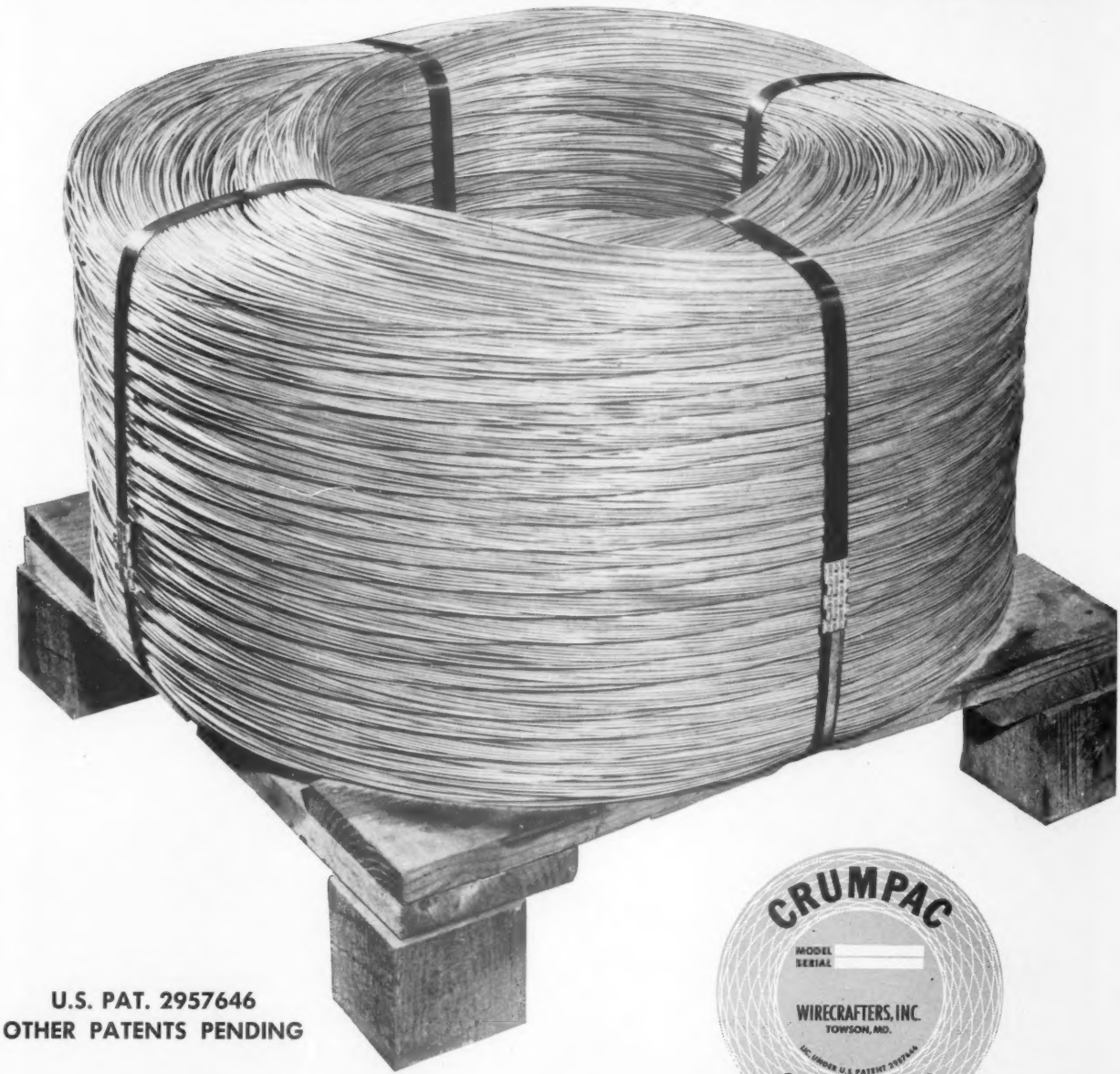
California

PRECISION PACKAGING—

IN LAYER AFTER LAYER OF TANGLE-FREE WIRE



U.S. PAT. 2957646
OTHER PATENTS PENDING

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WITH THE EXCLUSIVE HEAVY DUTY
CONVOLUTE DURA CURL RIMS

The Difference
IS HERE.....

NEW MPS CONVOLUTE DURA CURL RIMS...

The difference between just any spool or reel and Superior MPS CONVOLUTE DURA CURL Rims is well worth your close attention. Because now, with this exclusive MPS feature, maximum strength and rigidity are obtained throughout the reel heads. You can now have continuous trouble free high speed winding, without spool straightening expense. These new MPS spools also have the famous **No-Crev** feature.
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give you brute strength with dimensional precision, concentricity, and balance. Another patented MPS development engineered to **help you!**

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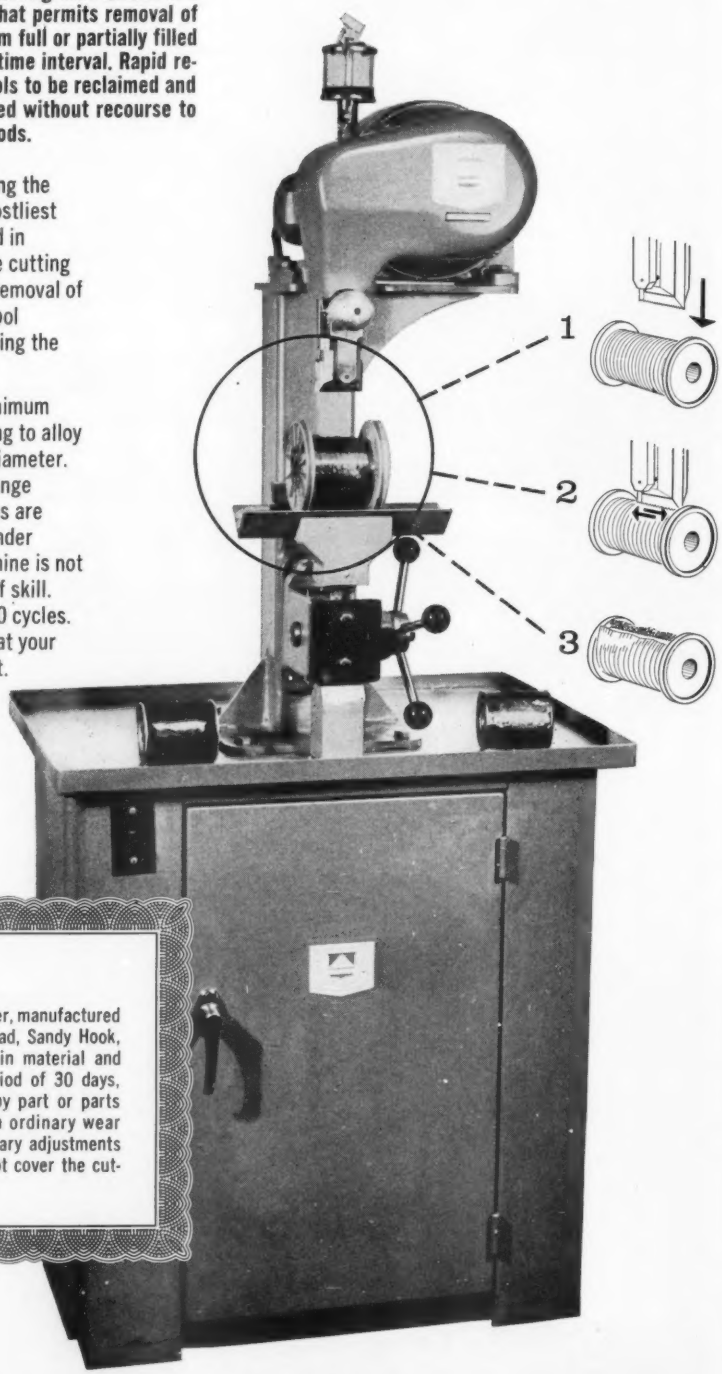
OSCILLATING WIRE CUTTER

SOLVES ONE OF THE COSTLIEST PROBLEMS IN THE INDUSTRY

The Watkins Oscillating Wire Cutter is a unique machine that permits removal of all wire alloys from full or partially filled spools in a short time interval. Rapid removal allows spools to be reclaimed and wire to be salvaged without recourse to costly hand methods.

Some of the largest companies in the country are using the Watkins Oscillating Wire Cutter to solve one of the costliest problems in the industry. Simple in design and rugged in construction, the Oscillating Wire Cutter has a unique cutting principle that shears wire turns on the spool, allows removal of the wire in seconds. Removal of the wire from the spool permits wire to be properly identified — thus increasing the scrap value and producing great savings.

The Standard machine, Model A, has a range from minimum diameter .0004" to maximum diameter .018" according to alloy and will handle spools from the smallest used to 8" diameter. The Heavy Duty model will handle spools up to 16" flange diameter, and wire diameter up to .050". Cutter blades are specially hardened and ground for good service life under reasonable care. The method of operation of the machine is not difficult to learn and does not require a high degree of skill. Electrical requirements are 220/440 volts, 3 phase, 60 cycles. The Standard machine is available for demonstration at your plant, within a reasonable distance, upon your request.



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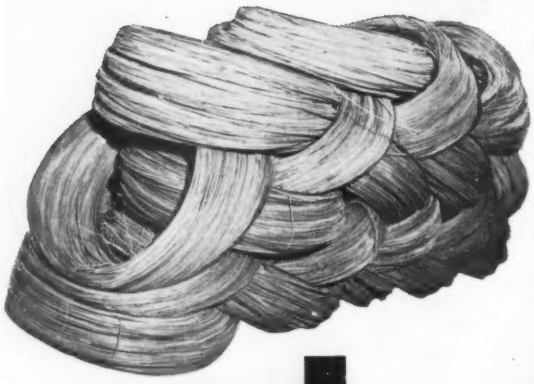

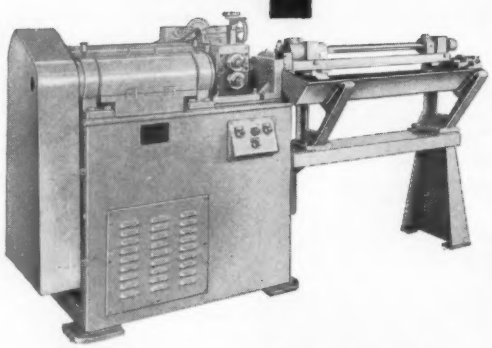

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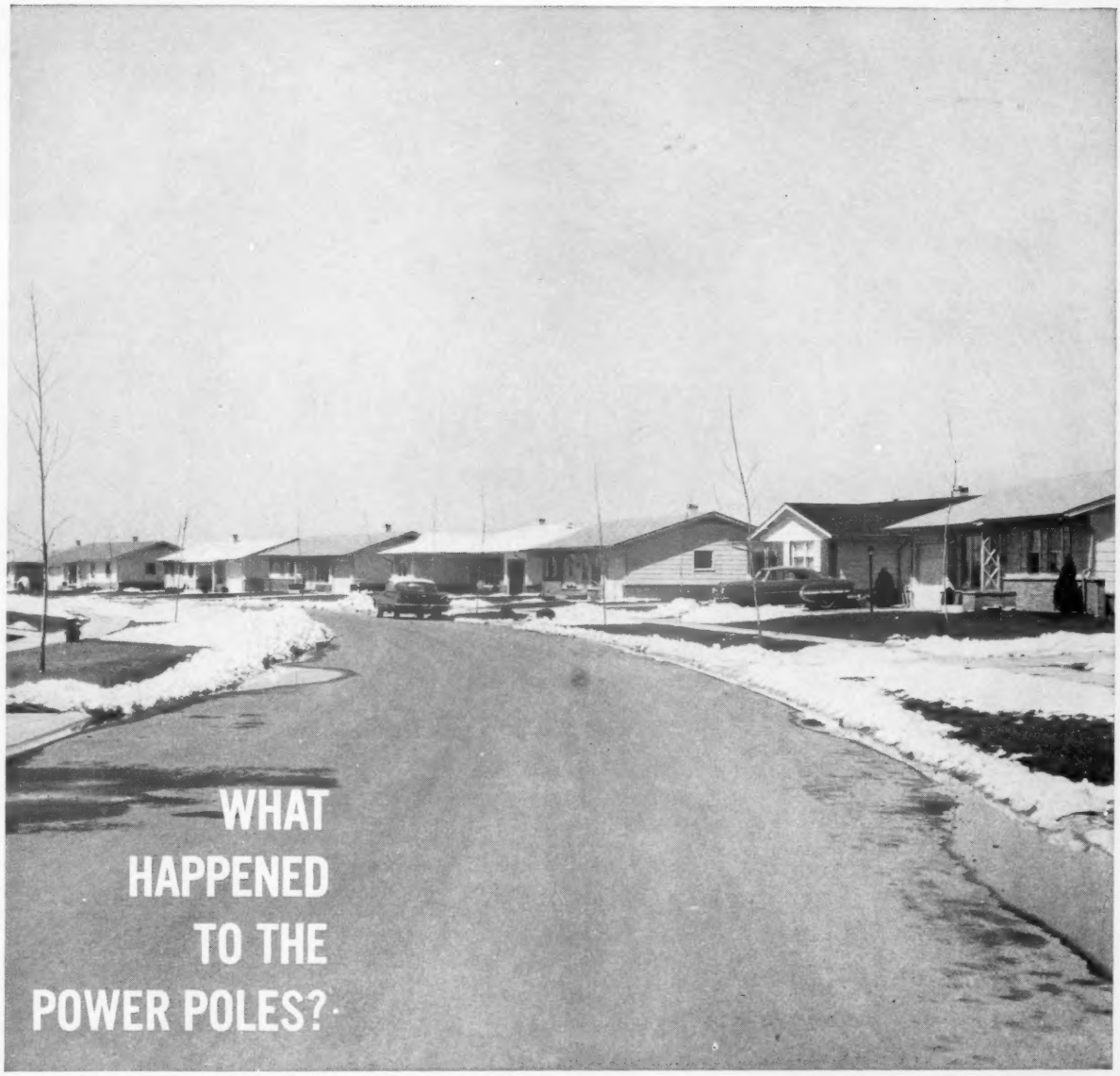

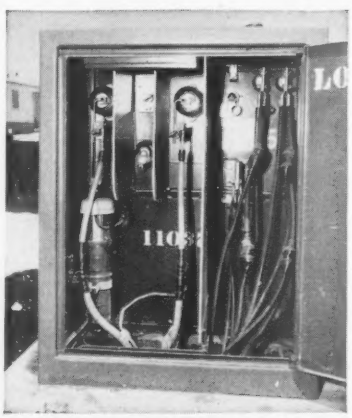

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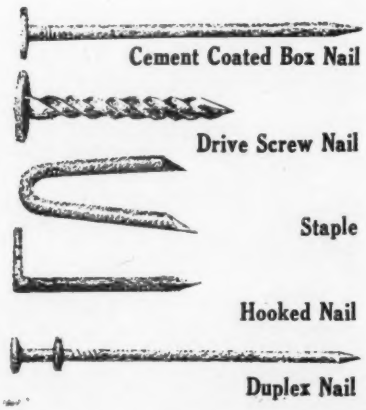

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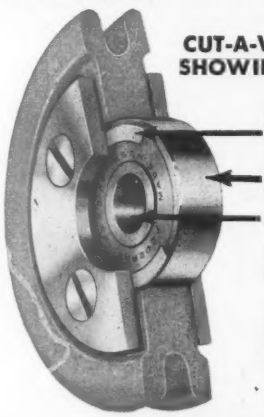

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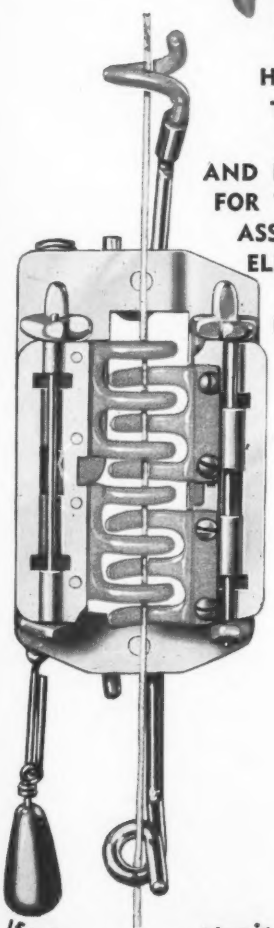

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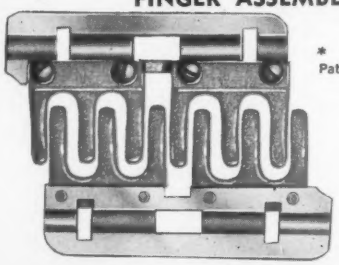

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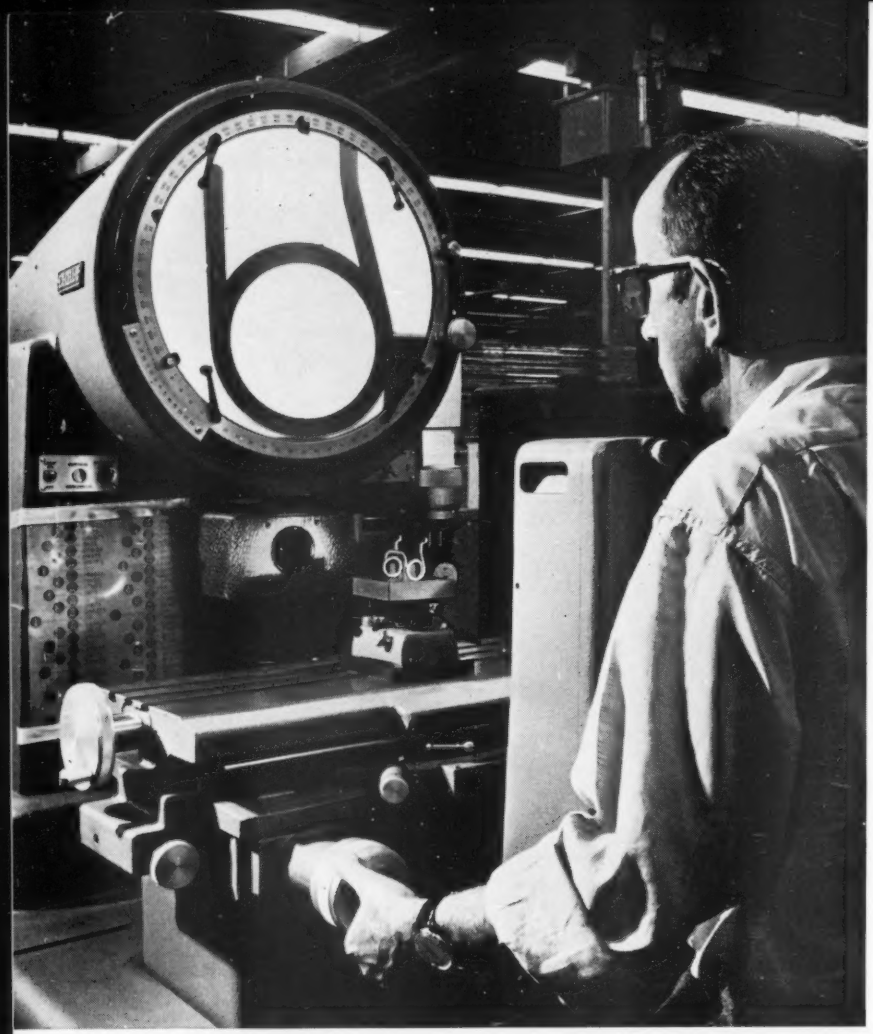


A profile of wire forming quality is cast by clutch vibration dampener spring on contour projector in Cuyahoga Products Corp's. quality control laboratory. Function of double-torsion spring is to soak up rattles in auto clutch. It's made from Pittsburgh Steel Company's oil tempered wire.

Cuyahoga Products Corp. Gets . . .

Long Production Runs—Precision Springs From Pittsburgh Steel Wire

Controlling the dynamic forces inside a clutch takes a special degree of strength and toughness in high carbon wire springs.

Cuyahoga Products Corp. of Charlotte, N. C., helps automotive clutch manufacturers do the job with pressure-plate and vibration dampener springs made from oil tempered wire.

Pittsburgh Steel Company is one of Cuyahoga's principal suppliers of oil tempered wire—as well as hard drawn MB spring wire, low carbon bright and galvanized wires.

Cuyahoga Products ranks as the South's biggest manufacturer of springs and wire forms. Following consolidation with American Spring of Holly Inc., Holly, Mich., it's newly installed in a modern, 400-man plant in Charlotte's Arrowood industrial district.

Automotive applications count for a substantial part of Cuyahoga's production.

And for measurement of Pittsburgh Steel wire quality, there's no better yardstick than consistent performance in the long production runs of precision-formed automotive springs.

Why does Cuyahoga specify oil tempered wire for its hundreds of applications of this type? John L. Moran, Vice President—Manufacturing says it's: ". . . because oil tempered has the physical properties necessary for extremely precise forming, and for greater fatigue life under high stresses."

Cuyahoga's supervisor of inspection and quality control added:

"In our sampling program, we'll allow a supplier a small margin of deviation. Then if their wire exceeds that, we correct matters simply by switching to another source.

"Pittsburgh Steel's wire shows up very well. Offhand, I can't recall any complaints about it—either here or when we were located in Cleveland."

Clutch plate—pressure springs are just one of thousands of types of springs and wire forms Cuyahoga is called on to produce.

But they represent a typical use of Pittsburgh Steel's oil tempered wire in jobs where precision form, uniform strength and faithful performance under high stress are critical.

Surface quality, ductility and tensile strength (narrower than commercial tolerances) are vital to Cuyahoga from standpoints of trouble-free production and quality control.

Cuyahoga produces one particular size of pressure-plate spring for a big automotive clutch manufacturer from Pittsburgh Steel's .177-inch oil tempered wire.

With closed ends ground square and chamfered, the spring contains precisely 5.6 coils, including 3.46 active coils, with a free length of 1.274 inches and an .875 inch O.D.

Compressed to 1.069 inches, each of five consecutive samples must register a load of 233-253 pounds in quality control load tests made every hour on production runs, as well as at each set-up and coil change.

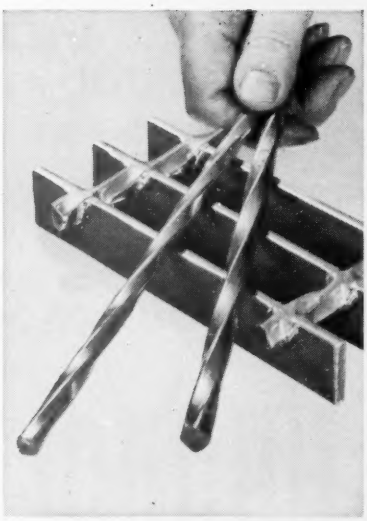
Because a friction clutch becomes a veritable beehive in operation, Cuyahoga also calls on oil tempered wire for toughness and fatigue resistance necessary to soak up clutch vibrations.

Produced on a 4-slide machine from .091 inch O.T. wire, this vibration dampener consists of a $2\frac{3}{16}$ inch double-torsion spring containing two $\frac{7}{8}$ inch O.D. turns and mounting lugs at each end.

Mounted in sets of six to provide a precise $\frac{13}{16}$ inch gap between clutch cover and pressure plate, dampener springs serve to eliminate a major source of irritating rattles.

Investigate Pittsburgh Steel's oil tempered wire for your own spring applications where steady, reliable performance are "musts" for profitable production. Helpful service and quick delivery from ample wire stocks are part of the Pittsburgh Steel package, too. Just contact one of the district offices listed on the adjoining page.

One of 65 types of auto door lock linkage systems produced by Cuyahoga Products, lock rod above is produced on specially adapted 4-slide machine at rate of 2,000 pieces per hour from .160 bright basic galvanized wire—much of it supplied by Pittsburgh Steel Company.



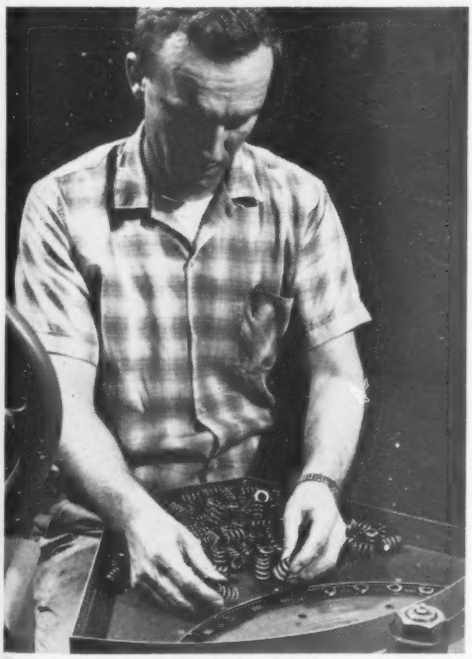
Ardox, Spiralled Wire Is Designed to Save You Time and Money

Production benefits grow quickly into dollar savings when you use spiralled Ardox wire, a new product from Pittsburgh Steel Co. This preshaped wire, designed for industrial grating and ornamental iron applications, is also delivered ready for fabrication into furniture and decorative housewares.

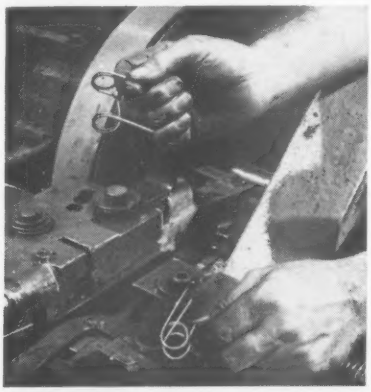
The uniform spiralled shape is achieved at the mill. Costly, time-consuming twisting operations in your plant are eliminated. You save time, labor and equipment. Because Ardox is cold drawn into its final shape, basic metallurgical qualities remain unchanged and you get more uniform strength.

Special dies used in the cold drawing process give Ardox a fine surface finish. Spirals are more precise and uniform. Painted or plated Ardox looks better and lasts longer. A special, double spiralled patterned surface design is also available.

Made of low carbon steel, or to your own analysis, if desired, Ardox is provided in any desired straight lengths. Diameters to your specifications.



Precise forming, long service under tough conditions are required of clutch plate pressure springs. Made by Cuyahoga from Pittsburgh Steel's .177 oil tempered wire, springs above are being ground square and chamfered.



Fatigue life, toughness of Pittsburgh Steel oil tempered wire are ideal for the job this clutch anti-rattle spring must perform.

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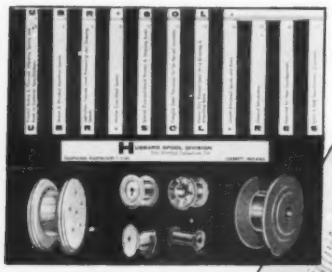

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The Wire Outlook

The rate and degree of recovery from last year's recession is exceeding even the optimists' earlier forecasts, with every indication that the country is heading into a boom. It has been the fastest recovery recorded by the Federal Reserve Board's index, with the GNP estimated to be at a rate of $516 billion in the second quarter.

However, all is not rosy in the outlook, for entirely apart from the Berlin threat of trouble, with wages going up and prices bound to follow, a new round of inflation is in the making. This could result in a new flight of gold from our reserves and another imbalance in world payments. This only could be checked by a trimming of the government's plans for spending, which it would be reluctant to do.

Personal incomes hit a record-breaking annual rate of $422 billion in July, people have been spending freely, and retail trade sales have been rising. Output of factories and mills has risen 10 percent above the low of last February and is higher than the last peak of early 1960. Employment is expected to rise, too.

Actually, the unemployment statistics issued by the government are not as bad as they are made out to be. In the first place, they are made up from a very small number of sampling interviews, and secondly, they include incapacitated people who cannot work, youngsters who had part or full time jobs in the summer, and many other classifications of people who do not or cannot work regularly. No other country gathers unemployment data as we do and it is said that all of the big European nations would show double the number of unemployed, if statistics were gathered as Washington does. This is just another example of the inability or failure of bureaucrats to be realistic. Our legitimately unemployed reports would be cut in half were they accurate. Moscow likes our methods and makes much capital of our figures.

Inventory buying is now in progress in anticipation of higher prices. Factory inventories rose by $220 million in July, but are not expected to get out of line. Construction activity hit a high in August for new plants, private housing and public spending. Small declines in heavy engineering projects and utility construction have been noted. Payments to farmers for price supports — and for not raising produce — will exceed any previous records in 1961, practically double that of last year. Business failures also hit a ten-month low in July.

In the wire industry production is running about 55 percent of capacity, with indications that it will improve in the Fall. The hardest hit are those in the areas of seaboard ports of entry, through which foreign rod, wire and wire products arrive in volume. Most improvement has been in specialty wire. While road reinforcing wire mesh has been doing well, demand does not come anywhere near capacity.

Orders for manufacturers' wire are rising slowly, but steadily. Demand actually is exceeding earlier forecasts. Automotive demand for wire is good and expected to increase further as the new models get into full production.

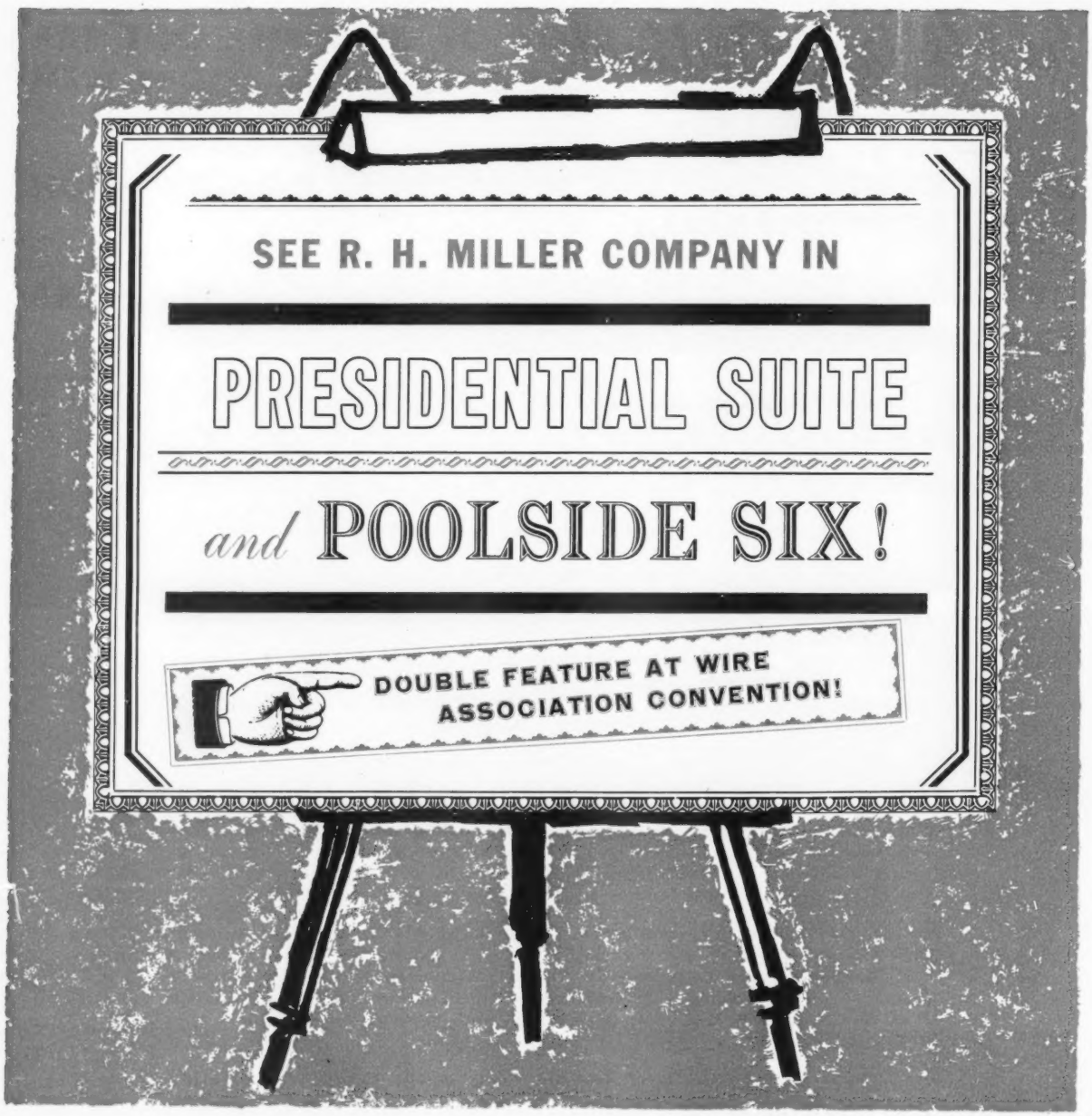
The chief economist for the National Industrial Conference Board pointed out recently that while an expansion in government spending is beginning to be felt, it is private business that has sparked the recovery pattern and that business overall would have improved without this additional impetus from Washington.

It may sound a bit repetitious to keep reporting better business from month to month, but at least it is the fact and adverse reports would have to be made if circumstances called for it.

Be that as it may, we are facing a period when everyone will be kept busy at those things each is best qualified to do.

Edmund D. Sickels

EDITOR



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Vol. 36 OCTOBER, 1961 No. 10

Wire Electrogalvanizing Process at The Steel Company of Canada Ltd. Dominion Works

by N. M. Switucha
Metallurgist, Development Group
Metallurgical Division
The Steel Company of Canada Ltd.
Montreal, P. Q., Canada

Synopsis

The factors affecting the operation of the electrogalvanizing line consisting of lead furnaces, cleaning, plating, waxing and drying facilities are described.

* * *

The interdependence of these operations and their respective significance in influencing the final quality of the electrogalvanized wire are discussed. Tables and charts derived from this relationship illustrate the dependence of the process upon such factors as current, time, solution composition, wire size and others.

* * *

The descriptive material is supported by photographs of the installation while the nature and quality of the end product obtained is illustrated by a series of microphotographs.

* * *

The presented data and derived conclusions are applicable to the modified Langbein-Pfanhauser type 28—wire electrogalvanizing unit of The Steel Company of Canada, Limited at Lachine, Quebec, Canada. However, the basic underlying operating principles may be applied to any similar installation with a new set of facts and figures to be derived.

N. M. Switucha

This paper was prepared for presentation at the Annual Convention of The Wire Association on October 25, 1961, at French Lick, Indiana.

Prior to his present position as Metallurgist, Development Group, Montreal Metallurgical Division, the author was engaged in wire specifications and subsequently in process and product development work in Montreal finishing plants. Before joining the Company in 1955 he was briefly associated with the nonferrous metal industry. His educational background includes Bachelor of Science degree (1955) and Diploma in Management and Business Administration (1961).

Introduction

The development and growth of the zinc electroplating industry within the last few decades stems from the creation and invention of various new electroplating processes. Within the wire branch of the ferrous industry a number of processes gained recognition as successful methods of electro-galvanizing offering additional advantages over the conventional hot-dip methods. One of the first commercially successful electrogalvanizing processes was developed by the Langbein-Pfanhauser Works in Germany. It became known as the L.P. process and was apparently the first to successfully solve wire handling problems and to develop advanced methods of wire cleaning.

These developments permitted production of — for that time — reasonably heavy electrogalvanized coatings having good surface appearance and excellent adherence characteristics.

* * *

Confronted with the necessity of satisfying increased demand from the Canadian market for the electrogalvanized steel wire, The Steel Company of Canada, Limited installed in 1938 an 18-wire L.P. unit at Dominion Works, in Lachine, Quebec. Two expansion programs have been undertaken and since 1958 the unit is operating as a modified 28-wire plant with an average monthly capacity of 450 net tons. The unit is capable of handling wire sizes of .050—.190 inches in high carbon analysis and from .050 to .250 inches in low carbon stock. The material produced varies in carbon content from .05 to .75 percent. The range of coating weights produced is a function of wire diameter with up to 1.0 oz. per sq. ft. coatings obtainable on all wire sizes. Recent modifications of the process permit production of high quality zinc coatings up to 3.0 oz. per sq. ft. on wire diameters up to approximately .165 inches.

* * *

The sequence of operations is as follows:

Pay-off system, two lead baths, acid pickling, water rinse, electrocleaning, silica stone cleaning, water rinse, plating, hot water rinse, inhibitor treatment, drying and take-up system. This sequence is illustrated in the schematic diagram of the installation, Fig. 1, and described in detail in the respective sections of this paper.

Heat-Treatment and Cleaning of Wire

The wire is delivered to the electrogalvanizing department from the Wire Mill in the required coil weights and is loaded on the revolving pay-off reels. Successive coils are joined together manually by twisted joints. These are kept reasonably small to avoid interference with lead sinkers, anodes, contacts, etc. when passing through the cleaning and plating tanks.

* * *

A chemically clean metal surface is vitally important for good adherence of zinc deposit. There are a number of consecutive cleaning processes designed to take care of the various types of foreign matter and metal oxides present on the steel surface.

Lead Bath

The function of a lead bath is twofold. It aids in removing drawing soaps and greases from the wire surface by combustion and determines the physical properties of the wire. Commercially pure molten lead is used as a heating medium due to its high thermal conductivity resulting in a rapid, uniform and efficient heating. Aside from its tendency to oxidize, lead is inherently stable in composition and free from a tendency to pit or decarburize the steel surface.

* * *

Two oil-fired lead pans, 15 ft. inside length each, are located immediately following the pay-off reels.

* * *

The desired wire physical properties require a close control of lead temperature and wire immersion time. Temperature range varies from 800°F to 1350°F depending on the steel stock processed and specification requirements. The immersion time is determined by the wire speed and varies approximately from 5 to 60 seconds. Charcoal ashes at the wire exit point wipe off adhering liquid lead globules, thus preventing lead dragout on the wire surface.

Hydrochloric Acid Pickling

The main purpose of this method of cleaning is the removal of the oxides formed on the wire surface as a result of lead heat treatment. Two granite pickling tanks, approximately 250 imperial gallons capacity each, are employed. The tanks are located at

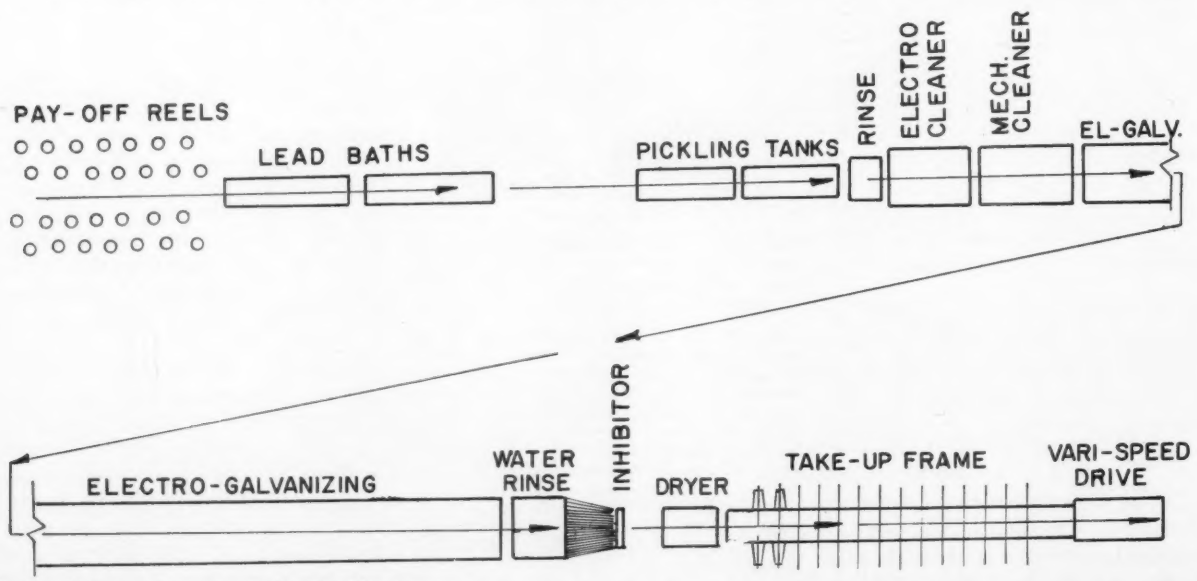


Fig. 1 — Diagram of 28 wire electrogalvanizing line.

a distance of 25 ft. from the lead pans to provide a cooling off period in the air before the wires enter pickling solution.

* * *

The solution is maintained at a concentration of 12 percent minimum 20° Be hydrochloric acid by volume and a temperature of 150°F minimum. The solution strength is controlled daily by chemical analysis, thus determining the frequency of additions and of the periodic dumping of the spent liquid.

* * *

In most cases the use of only one tank is indicated due to a danger of overpickling high carbon material if the wires are permitted to remain in a hot hydrochloric acid solution excessively long. Two tanks are used on high speed wire having inferior surface quality as well as on all fine sizes of low carbon analysis.

Electrolytic Cleaning

Hydrochloric acid pickling is followed by a cold water rinse and supplemented by the electrolytic cleaning. The design of the electrocleaner is based on the principle of the anodic connection of the wires while 36 in. long lead plates immersed in a sulphuric acid solution serve as cathodes.

* * *

The positive polarity of the wires repels the positively charged particles of dirt, soap or metal ions that normally form smut. The action of the current causes metallic iron to pass into the solution thus helping to remove the oxides remaining on the wire surface. The resulting etching of the surface improves the adherence of the subsequent zinc deposit.

* * *

Current flow in the electrolyte liberates hydrogen on the lead cathodes while oxygen is evolved on the wire surface. The potential danger of hydrogen embrittlement of the steel wires is thus eliminated. The process can be represented by the equations:

$$2H^{+} + 2e \longrightarrow H_2$$

$$4OH^{-} \longrightarrow 2H_2O + O_2 + 4e$$

Another advantage of the direct contact anodic system is an efficient utilization of the current in that it passes directly from the wires to the cathodic plates thus minimizing possible losses in the electrolyte. The current magnitude necessary to obtain an efficient cleaning action varies with the wire diameter and the steel composition.

* * *

Electric current is supplied by a 6 volt, 2500 amp capacity d-c generator by means of two sets of revolving bronze sheaves connected to the bus bars by mercury contacts.

* * *

The wires are immersed in a 15 percent by weight sulphuric acid solution for a distance of 4 ft. and are maintained approximately one inch below its level by two sets of revolving porcelain sheaves. Solution uniformity with respect to temperature and concentration is maintained by employing low intensity air agitation. Solution temperature is a critical factor in obtaining an efficient cleaning action and it is not permitted to exceed 90°F. Cooling water is circulated in a system of lead pipes inside the electrocleaning tank, which has a total capacity of 1150 imperial gallons.

Rinsing and Stonescrubbing

After leaving the electrocleaner the wires pass under a cold water spray into a 13 ft. long wooden tank filled with fine, sharp-edged, 1¼ in. silica gravel. An ample water supply from sprays is provided to wash away any loosened smut on the surface, as well as to reduce channeling due to the passage of wires through the gravel.

* * *

Improper cleaning, adherent lead-globules or steel surface defects all have a detrimental effect on the subsequent quality of zinc deposits.

* * *

Coating irregularities associated with such defects are illustrated in Figs. 2, 3 and 4.

* * *

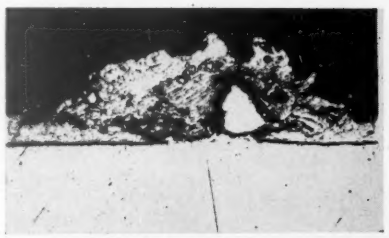


Fig. 2 — Photomicrograph showing a serious defect in coating quality resulting from the presence of scale and a globule of lead on the wire surface. Wire diameter .165 in., weight of coating .80 oz. per sq. ft. etched in 3 percent nital. Mag. 100X * * * * * *

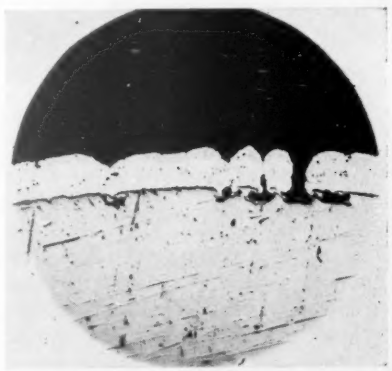


Fig. 3 — Diam. .207 in. coating 1.5 oz. per sq. ft. Effects of the defective steel surface on formation of voids in zinc coating. Etched in nital. Mag. 100X * * * * * *

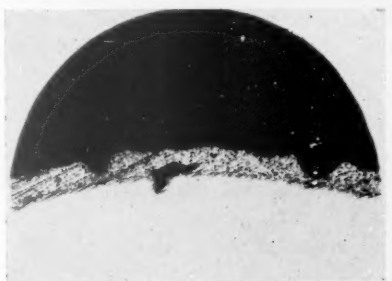


Fig. 4 — Diam. .104 in. coating 1.15 oz. per sq. ft. Effects of the defective steel surface on formation of voids in zinc coating. Etched in nital. Mag. 100X * * * * * *

Principles of Electrodeposition

Faraday's Laws

The process of electrodeposition is governed by a known quantitative relationship expressed by the two Faraday's Laws. They relate the mass electrolyzed to the quantity of electricity passing through the cell and to the equivalent weight of the element. From this relationship the value of the Faraday and the electrochemical equivalents of zinc can be calculated.

* * *

TABLE I

Electrochemical Equivalents of Zinc at 100 Percent Current Efficiency

Atomic Weight	**65.38**

Valence	2
Equivalent Weight	32.69
Electrochemical Equivalents	
g per amp hr	1.219
amp hr per g	.82
amp hr per lb	371.94
amp hr per sq ft for .001 in	13.7

* * *

According to the electrolysis theory, electrical current applied to the electrolyte will charge the anode positively and the cathode negatively. By giving up two of their electrons, zinc atoms pass into the solution becoming positively charged ions.

* * *

At the anode: $Zn^{\circ} - 2e \longrightarrow Zn^{++}$
While at the cathode:
$Zn^{++} + 2e \longrightarrow Zn^{\circ}$

Under ideal reaction conditions the rate of oxidation of metallic zinc to form zinc ions and the rate of reduction of ions and their deposition on the cathode as metallic zinc are equal. Since the electrolytic medium is a zinc sulphate solution containing in addition to the zinc ions also sulphuric acid, water and aluminum sulphate, additional reactions involve evolution of hydrogen at the cathode and the formation of oxygen and sulphuric acid at the anode.

$$ZnSO_4 \cdot 7H_2O \longrightarrow Zn^{\circ} + H_2SO_4 + 6H_2O + 1/2\ O_2 + \text{heat}$$

The reactions may be detailed as follows:

$$ZnSO_4 \rightleftarrows Zn^{++} + SO_4^{=}$$
$$SO_4^{=} = SO_4 + 2e$$
$$SO_4 + H_2O = H_2SO_4 + \tfrac{1}{2}O_2$$
$$H_2SO_4 \rightleftarrows 2H^{+} + SO_4^{=}$$
$$H_2O = 2H^{+} + \tfrac{1}{2}O_2 + 2e$$
$$Zn^{++} + 2e = Zn^{\circ}$$

Ohm's Law

Another important rule governing the electrodeposition process is given by the Ohm's Law which relates the electromotive force applied to a conductor and the current strength. Thus the current strength (I) is directly proportional to the applied electromotive force (E) and inversely proportional to the resistance (R).

$$I\ (\text{amps}) = \frac{E\ (\text{volts})}{R\ (\text{ohms})}$$

Since resistance (R) is reciprocal to conductance (C) then by replacement of (R) in the above equation by $\frac{I}{C}$ it becomes $I = EC$.

Furthermore, if

K = specific conductance of the electrolyte
a = exposed areas of electrodes
L = distance between electrodes

Then conductance of solution

$$C = \frac{Ka}{L}$$

Ohm's Law can now be modified to show that:

$$I = \frac{EKa}{L}$$

* * *

Thus the current strength is proportional to the product of voltage by specific conductance and by the exposed areas of the electrodes and inversely proportional to the distance between the electrodes.

* * *

In practical application an increase in current strength within limits may be achieved by an increase in voltage applied, an increase in the acid and/or metal ion concentration of the electrolyte, as well as an increase of the exposed areas of the electrodes. Similar effect may also be achieved by decreasing the distance between the wires and the anodes.

Current Efficiency

Current efficiency, which can be defined as the ratio of the actual current yield to the theoretical yield according to the Faraday's Law, is rarely 100 percent in any process. A relatively high average current efficiency of approximately 95 percent obtained in a zinc sulphate plating bath of the type described is governed by such factors as current density, conductivity of the solution, acidity, temperature, concentration of the electrolyte, anode and cathode polarization.

* * *

The reduction of current efficiency is due to a tendency to produce secondary reactions such as liberation of hydrogen at the cathode, oxygen at the anode, oxidation of the impurities at the anode and their reduction at the cathode.

* * *

An increase of the efficiency of the anode over that of the cathode results in a change of bath concentration since more metal is dissolved from the anode than is plated out at the cathode. Conversely, a decrease in anode efficiency is followed by a gradual depletion of the solution with respect to the zinc ions and a consequent decrease in the pH value.

* * *

Table II shows weight of zinc deposited by current in our operating range of up to 42,500 amperes in one minute at 95 percent average current efficiency of our bath.

* * *

Table II
Weight of Zinc Deposited in Relation to Current Magnitude in One-Minute at 95 Percent Cathode Efficiency

Current, Amps	Weight of Zinc Deposited, Oz
43,000	29.25
42,000	28.58
41,000	27.95
40,000	27.25
39,000	26.55
38,000	25.90
37,000	25.25
36,000	24.50
35,000	23.85
34,000	23.15
33,000	22.45
32,000	21.80
31,000	21.10
30,000	20.45
29,000	19.75
28,000	19.05
27,000	18.40

Electrogalvanizing Process

The wires enter the solution guided by partially immersed revolving porcelain sheaves and travel approximately one inch below the solution level. The cathodic connection is accomplished by 14 lines of revolving bronze contact wheels with each pair of contact wheels on a common shaft. The distance between any two wires is 3 in.

* * *

Extruded zinc anodes are immersed in the solution at intervals of 6 in. with two wires running between each pair of anodes. In addition to clamps holding the anodes in position and supplying the current, wooden supports have been installed to prevent anodes from accidentally falling down to the bottom of the plating tank. A possible direct contact between the positively charged anodes and the negative-

TEAR OUT ON PERFORATIONS

A fast look at 12 details of the machines we

will make wire enameling histo

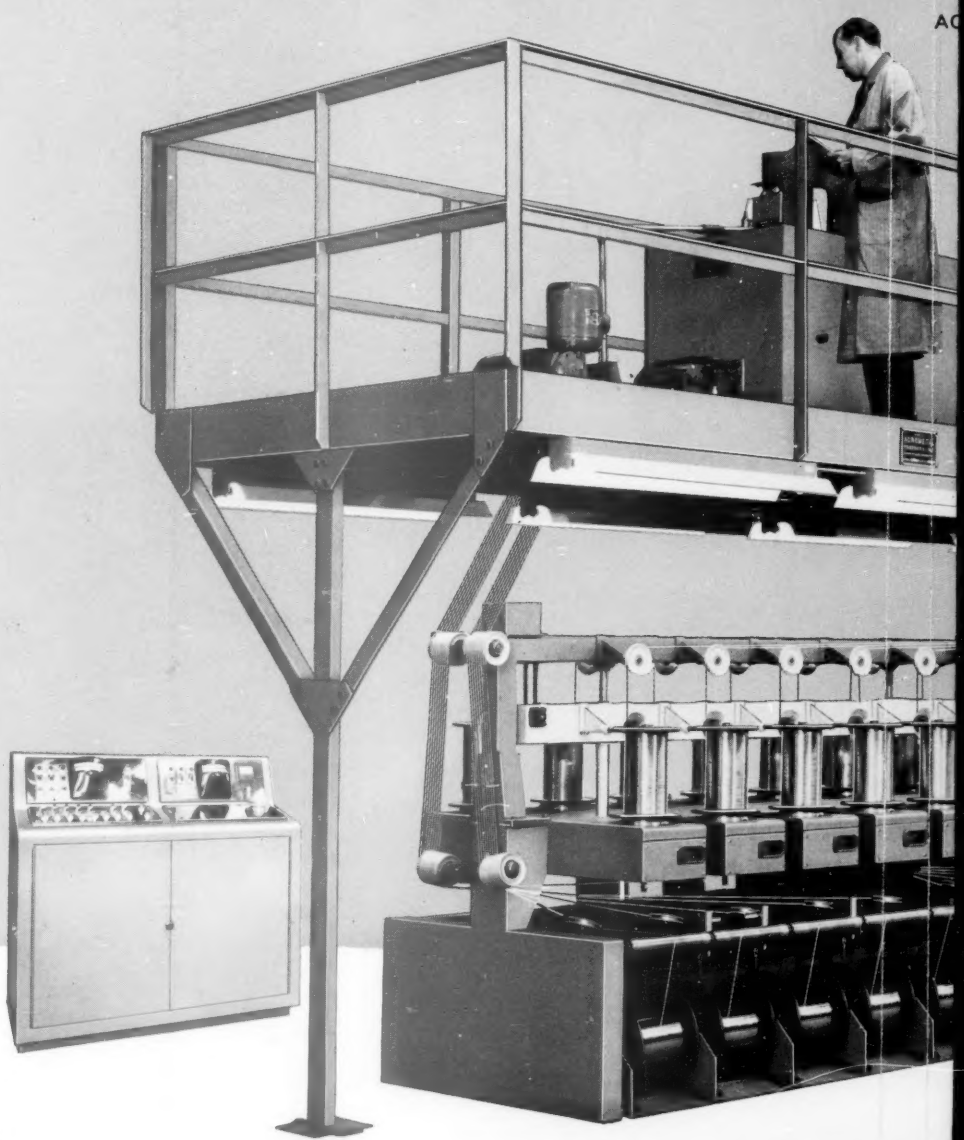
Designed and built by men with long experience in the Wire Industry

★ Die-less application of enamel eliminates the use of conventional clip, ball, and roller dies.

★ Vertical Spindle Take-ups accommodate the new ACROPAK long traverse reels for larger packages —as well as the conventional spools used in the industry today.

★ If desired, combination Take-ups can be supplied for spool, reel and pail or drum packaging.

★ Pushbutton Console fully controls operation of the complete enameling system. Individual components of the system are available with self-contained controls.



Featuring Vertical Spindle Take-up and Long Traverse reels —the combination that is now producing lower-cost, trouble-free packaging for the Wire Industry.

★ Traverse drive easily ad
produce either a str
tapered wind on a strai
spool. Particularly app
long traverse reel pack

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long experience in the Wire Industry

(Illustrated here is the
ACROPAK V-12 SYSTEM)

★ Traverse drive easily adjusted to produce either a straight or tapered wind on a straight barrel spool. Particularly applicable to long traverse reel packaging.

★ Self-
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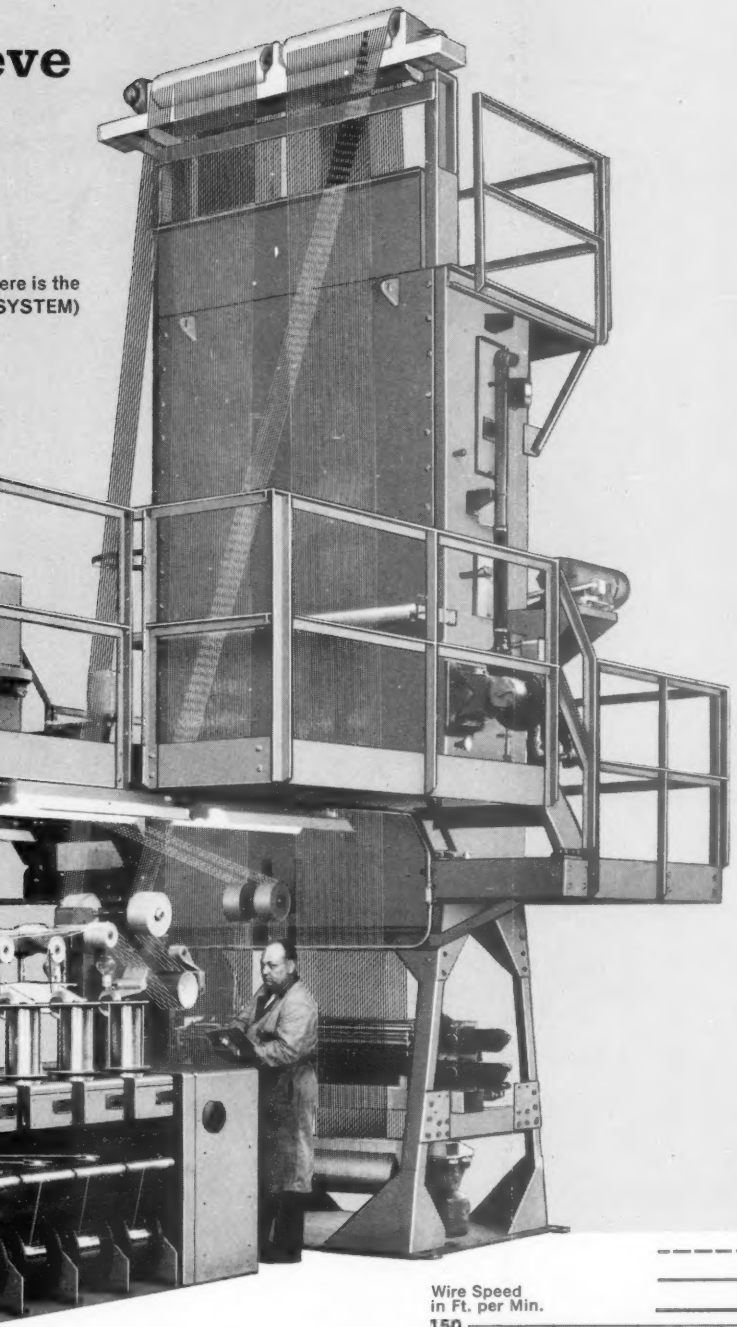


★ High convection Oven designed for high speed operation with effective baking pattern *controllable* throughout length and width of oven.

★ Capstan Drives (completely synchronized) provide controlled tension from the moment wire enters annealing oven until it is delivered to the take-up reels or spools.

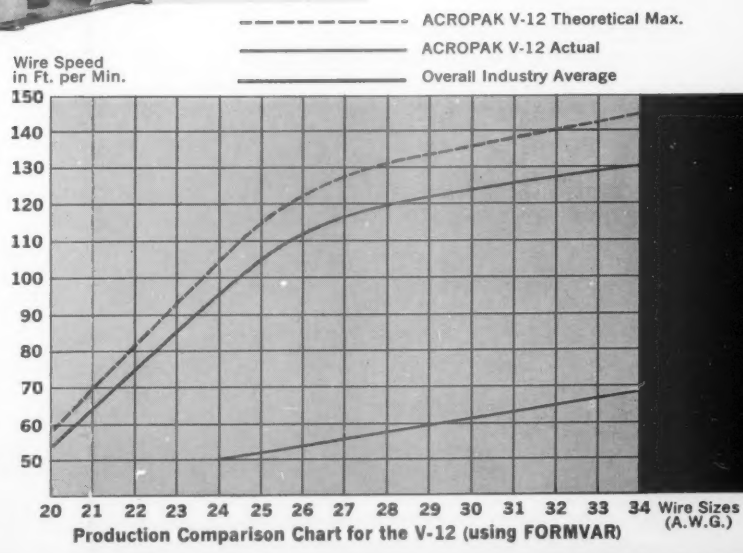
★ High convection Annealer, with self-generating super heated steam atmosphere, produces high quality annealed wire at exceptional speeds.

★ Precision, ball bearing, rolled aluminum Sheaves (both plain and overlapping) guide the wire throughout the system without nicks or scratches.

★ Water cooled bearings are used in upper oven Sheave Assembly to assure adequate heat dispersion. Power assisted sheaves are employed for fine wire sizes to reduce drag.

★ All exterior surfaces of the equipment are coated with high quality acid-resistant finish to assure long lasting attractive appearance.

★ Self-contained Let-off Stands can be replaced if desired by pail packer. Let-off Stands are easily accessible to operator and quickly adjusted for tension control.

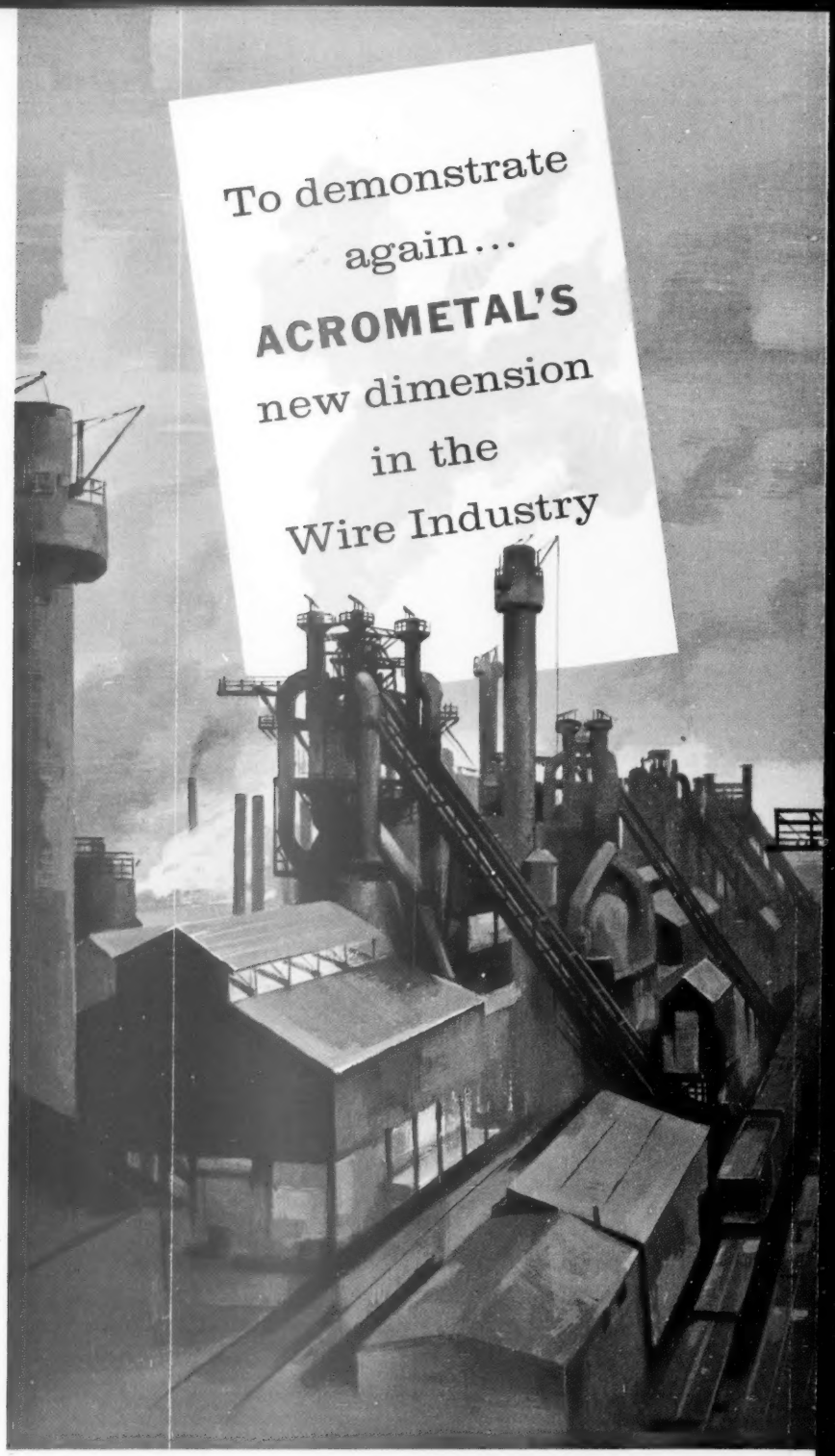


Production Comparison Chart for the V-12 (using FORMVAR)

UCTS, INC.

• **Phone FE. 8-7543**

for packaging wire

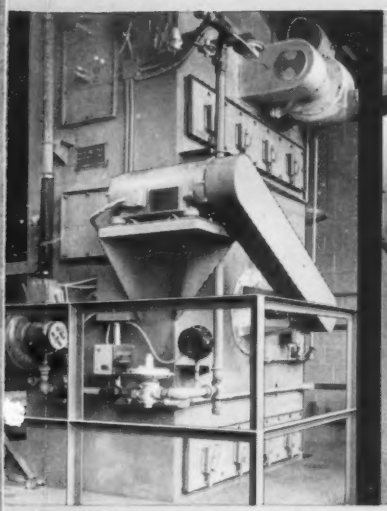


Announcing the New

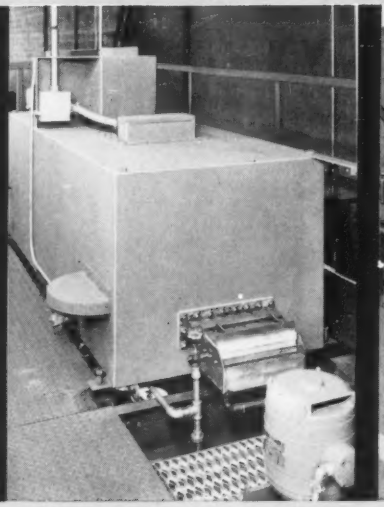
ACROPAK COMPLETELY INTEGRATED ENAMELING SYSTEMS

In Seven Sizes: V-24, V-18, V-12, V-8, H-7, H-3 and H-2

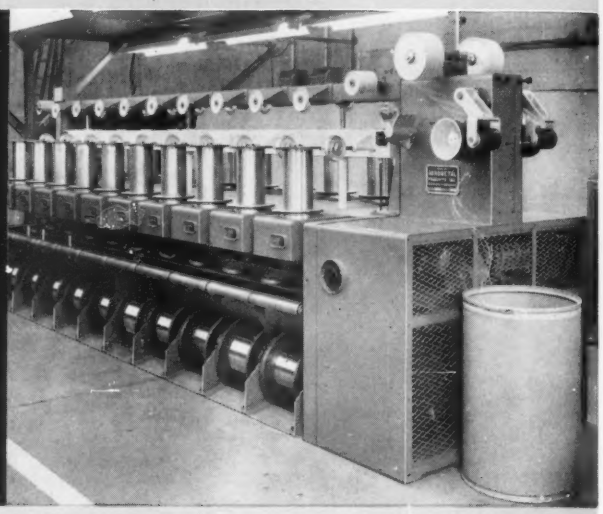
UNITIZED COMPONENTS... FUNCTIONALLY ENGINEERED ...AVAILABLE SEPARATELY IF DESIRED



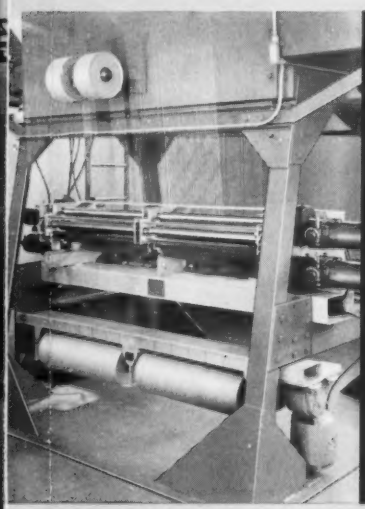
OVEN
Vertical two-zone gas or electrically heated convection recuperative type, with controlled velocity and temperature gradient.



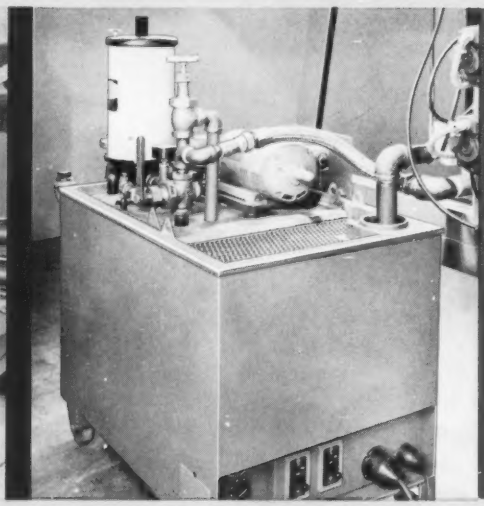
ANNEALER
Electrically or gas heated high-convection type, with self generating atmosphere. Equipped with simplified water seals.



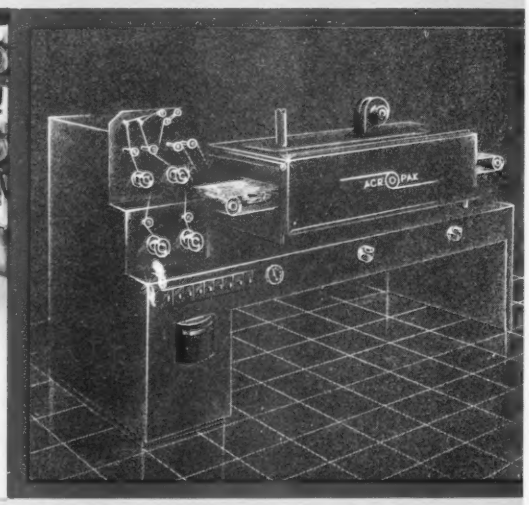
TAKE-UP
Spindles (either vertical or horizontal) driven by individual torque motors. Self delivery capstans. Traverse driven by individual I.V. drive and easily adjusted for varying lay.



ENAMEL APPLICATOR
Die-less . . . to assure concentricity and uniformity of end product. Reduces set-up time and eliminates die costs and maintenance.



ENAMEL SUPPLY SYSTEM
In various sizes, complete with automatic temperature and manifold pressure controls, and filtering system. ACROPAK automatic viscosity control also available and recommended.



MICRO ENAMELING SYSTEMS
For wire gauges #45 A.W.G. to .0004 diameters. Electrically heated, catalytic incinerating oven, powered let-off spindles, torque motor take-up spindles, die-less applicator and integrated enamel supply system.

General Specifications of ACROPAK ENAMELING SYSTEMS

SYSTEM	Oven Type	Std. AWG Size Range	Number Spindles	Number Passes	Approx. Wire Speed	Effective Heating Length	Type Die	Wire Speed Control Zones
V-24	24′ Vertical	8-18	20	120	20-67	23	Die-less	2
V-18	18′ Vertical	16-26	20	120	45-125	17	Die-less	2
V-12	12′ Vertical	24-34	20	120	95-130	11	Die-less	2
V-8	8′ Vertical	30-40	20	120	100-170	7	Die-less	2
H-7	7′ Horizontal	36-46	16	96	130-225	6	Die-less	1
H-3	3′ Horizontal	46-51	8	48	200	3	Die-less	1
H-2	2′ Horizontal	50-.0004″	2	24	200	2	Die-less	1

(Above Specifications based on FORMVAR)

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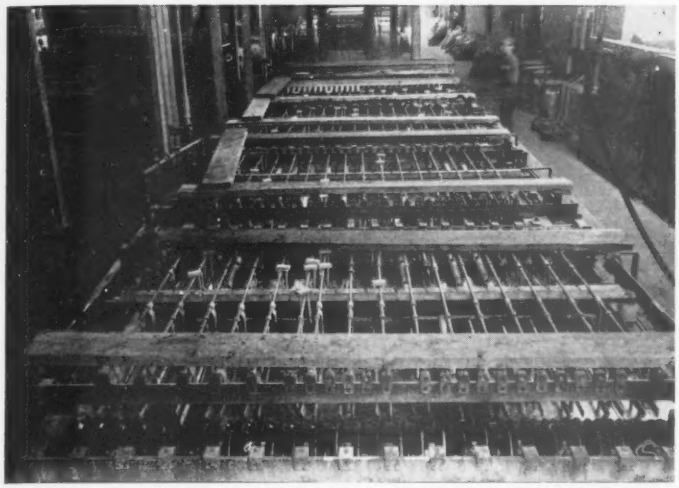

Fig. 5 — General view of the the exit end of the plating tank. In the foreground are revolving cathodic contacts and behind them zinc anodes hanging on copper supporting rods. In the background is the take-up unit with coils of finished wire visible on both sides.

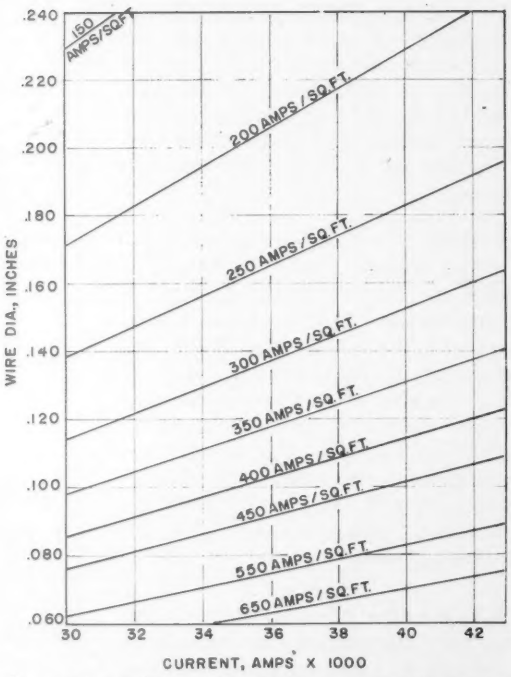

Fig. 6 — The effect of wire diameter on cathodic current density.

ly charged wires is prevented by partially immersed plastic anode guards. A general view of the plating tank is shown in Fig. 5.

Current Density

Current Density, which can be expressed as the ratio of the total current to the total area, varies in our process from approximately 190 amps per sq. ft. for .250 in. diameter to approximately 680 amps per sq. ft. for .065 in. diameter. The variation is shown in Fig. 6 from which it is evident that the existing generating capacity is the limiting factor in obtaining higher current densities.

* * *

The total wire cathodic area in a continuous wire galvanizing process can be calculated as follows:

$$C.A. = \frac{\pi \; d \; w \; l}{12}$$

Where:

C.A. = Cathodic Area, sq ft
π = 3.1416
d = wire diameter, inches
w = number of wires run concurrently
l = length of plating tank, ft

* * *

This information, based on our process, has been calculated for standard wire sizes and is reported in Table III.

* * *

Within certain limits an increase in current density tends to decrease the crystal size. This decrease is due to an increased rate of fresh nuclei formation resulting in fine-grained deposits, since excessive growth of individual crystals is thereby prevented. However, if current density is increased to the point when the rate of deposition exceeds the maximum rate of diffusion of ions, with the resulting local differences of concentration and depletion of the cathodic solution layer, then hydrogen will be discharged at the cathode. Evolution of hydrogen bubbles causes irregular growth of the deposit, formation of protruding crystals, porosity, and sponginess. Rapid discharge of hydrogen ions results in a lower acidity of the cathodic solution layer with a possible consequent precipitation of aluminum in a hydroxide form.

The effect of higher current density could be counterbalanced by a higher concentration of the electrolyte. The presence of an excess of zinc ions increases the tendency for new nuclei formation with the resulting firm and fine grained deposits. Agitation of the solution has similar effect in that it increases the rate of diffusion of ions to the cathode and increases current efficiency. Increased wire speeds permit an application of higher current densities due to depolarizing action on the cathodic surface and the wiping effect of a rapid solution counterflow. While the cathodic current density depends on the wire diameter, the anodic current density is determined by the actual dimensions and the total number of the an-

TABLE III

Variation of the Cathodic Surface Area in Relation to the Wire Diameter

Data: 28 wires and 120 ft. length of plating tank.

Wire Diam. Inches	Total Cathodic Surface Area, sq. ft.	Wire Diam. Inches	Total Cathodic Surface Area, sq. ft.
.0540	47.5	.1483	130.4
.0625	54.9	.1620	142.4
.0720	63.3	.1770	154.8
.0800	70.3	.1875	164.8
.0915	80.4	.1920	168.8
.1055	92.7	.2070	181.9
.1205	105.9	.2253	198.1
.1350	118.7	.2500	219.8

odes in the bath. Assuming the presence of a complete set of full-sized anodes, the current density is approximately 36 amps per sq. ft. of anodic surface. This value tends to increase with the progressive depletion of the anodes.

Voltage

The voltage necessary to maintain a given current density is proportional to the total resistance of the system, with the resistance of the solution being of the greatest importance. Resistance decreases with decreasing distance between the electrodes, increasing concentration of zinc sulphate and sulphuric acid, increasing temperature, and increasing wire diameter.

* * *

The value of 2.35 volts, given as the theoretical decomposition voltage of zinc sulphate solution, can be calculated from the heat of the reaction. In practice voltage in excess of 6.0 volts is applied in order to obtain maximum current input and consequently maximum tonnage output.

Current Distribution

Current distribution in the plating tank is governed by the electrical capacities of the generating units. Repeated expansion programmes of the unit capacity necessitated installation of the additional generating equipment and presently the unit is operating with three rotary-type d-c generators and two rectifiers having a total capacity of 42,500 amps. Their individual capacities are shown in Table IV.

* * *

The number of cathodic contacts and zinc anodes connected to any one unit is proportional to the maximum capacity of that unit, thus dividing the plating tank into four sections with approximate area ratio of 1/3: 1/4: 1/4: 1/6.

Electrolytic Plating Solution

The total volume of the plating solution is approximately 12,500 imperial gallons or 59,250 liters. The volume is subject to limited variations depending on the solution level in the tank,

TABLE IV
Capacity of the Generating Equipment

	Section 1	Section 2	Section 3	Section 4
Generating Equipment	Rectifiers #1 and #2	Generator #1	Generator #2	Generator #3
Capacity—Amps —Volts	15,000 12	10,000 6	10,000 6	7,500 6
Length of Section covered	40 ft.	29 ft. 6 in.	29 ft. 6 in.	23 ft. ⅝ in.

TABLE V
Composition of the Electrolytic Plating Solution

Substance	Average Composition	Total Weight, Lbs.
Zinc Sulphate ($ZnSO_4.7H_2O$) of which Zinc is 22.7% by weight	750 g per l	98,000 22,270
Aluminium Sulphate ($Al_2(SO_4)_3.18H_2O$) of which Aluminum is 8.1% by weight	25 g per l	3,270 265
Ferric Oxide (Fe_2O_3) of which Iron is 70% by weight	.8 g per l	104 72.7
Sulphuric Acid (66° Be H_2SO_4)	1.8% by vol	3,847

rate of evaporation of water, rate of drag out, and the volume of the solution in the reserve tanks. Total weight of all constituents including water is approximately 172,500 lbs. The overall dimensions of the plating tank are as follows:

length	122 ft. ⅝ in.
width	8 ft. 3¼ in.
depth	2 ft.

* * *

The average composition of the electrolyte and the total average weights of the individual constituents present in the total volume are reported in Table V.

* * *

The most important reaction from the point of view of electrodeposition is the reduction of zinc ions to the metallic form:

$$Zn^{++} + 2e \longrightarrow Zn^{\circ}$$

* * *

According to the table of standard reduction potentials, the potential required to bring about the above process under ideal reaction conditions, is -0.76 volts while that necessary to evolve hydrogen is zero volts. It is to be expected, therefore, that when the solution is electrolyzed hydrogen alone and no zinc should be liberated at the cathode. However, a phenomenon known as overvoltage alters the picture completely.

Hydrogen Overvoltage

Hydrogen overvoltage can be defined as the difference in the actual potential of an electrode at which gas evolution occurs and the theoretical reduction potential for the same electrode under identical solution and reaction conditions. The values of hydrogen overvoltage vary with the nature of the electrolyte, pH, current density, temperature and the condition of the electrode surface. Hydrogen overvoltage at a zinc cathode is 0.70 volts which implies that hydrogen evolution will be delayed until a potential of .70 volts has been obtained. Once this potential is achieved deposition of zinc and evolution of hydrogen will proceed simultaneously, since the two values are very close.

* * *

However, by changing reaction conditions, hydrogen evolution potential may be influenced. Increased current density and higher pH increases hydrogen overvoltage as does increased metal ion concentration, but increased temperature has the opposite effect. Acidity of the electrolyte is of particular significance in influencing hydrogen deposition potential and may be explained by

the equilibrium potential equation:

$$E = \frac{Eo + 0.059 \log C \cdot V}{Z}$$

Where: E = cathode potential required for deposition.
Eo = standard potential of a given element.
Z = valence of the element in solution.
C = concentration of the ions, gram-ions per liter.
V = hydrogen overvoltage, approximately 0.70 volts.

Since the standard potential for hydrogen is zero, the valence of hydrogen is one, and, by definition, pH is -log (H^+); this equation becomes:

$$E = -0.059\ pH - 0.70$$

Substituting known pH values, it can be seen that for a pH value of 2.0 the deposition potential for hydrogen becomes 0.818 volts while for a value of 4.0 it is increased to 0.936 volts. The greater the difference in the relative values between the discharge potential of zinc and hydrogen the fewer hydrogen bubbles will form at the cathode.

Control of pH

Hydrogen ion concentration of the electrolytic solution is measured in terms of pH with a pH meter (Beckman 7400, Model W) which has been designed for continuous operation in recording the pH value and regulating acid additions to the electrolyte. A special control system determines the rate of acid flow from the storage tank depending on the setting of the recording apparatus. This dropwise flow of acid assisted by agitation and movement of the wires maintains a uniform acidity of the solution throughout the tank.

Density of the Electrolyte

The density of the electrolytic solution is affected mainly by the zinc sulphate and acid contents since the effect of other constituents is negligible. A decrease in density may be due to an excessive dragout, higher cathodic than anodic current efficiency, insufficient frequency of anode replacement or the presence of passive anodes in the bath.

* * *

Increasing density indicates high anode efficiency and results in higher conductivity with subsequent increase in cathode efficiency.

* * *

The solution is maintained at 36 to 42° Be which corresponds to a specific gravity of 1.33 to 1.41 respectively. For continuous measuring and recording purposes a Densitrol unit, operating on a constant volume-variable weight principle, has been installed.

Additions of Aluminum Sulphate

The ability to oscillate between alkali and acid properties and thereby resist a change of pH upon addition of acid or alkali is known as buffer action. It is for this purpose that aluminum sulphate is added to the electrolyte reducing within limits, excessive acidity variations. Additions are made in predetermined quantities on a weekly basis by first dissolving the solid salt in a small quantity of the electrolyte at elevated temperature and then mixing it with the bulk of the solution.

Temperature

The basic reaction in the electrolysis of zinc sulphate solution is exothermic, as heat is liberated in the process of electrolysis. Current input also generates a substantial amount of heat which varies with the sum of the products of current and voltage for each unit. Thus, at a maximum total input of 345 kw per hr. the heat input is equal to approximately 1,177,000 Btu per hr.

* * *

The rate of increase of the bath temperature depends on the resistance of the system, the volume of the solution and the rate of dissipation of heat. This latter factor depends upon:

1. **The relative temperature of the surrounding atmosphere and the bath.**
2. **The thermal conductivity of tank walls.**
3. **The rate of evaporation.**
4. **The heat carried away by cooling coils, bus bars, and wire itself. The heat loss from the top surface of an uncovered tank varies with temperature and is approximately 550 Btu per hr. per sq. ft. at 110° F and approximately 1100 Btu per hr. per sq. ft. at 140° F. Thus the heat loss by natural causes was insufficient to maintain solution temperature at a recommended level of 105 to 110° F and this made it necessary to install a heat exchanger of 500,000 Btu per hr. capacity.**

* * *

The effect of temperature on the nature and quality of coating is governed by the following interrelated factors:

1. **Increase in temperature favours diffusion of metal ions to the cathode.**
2. **It decreases the resistance of the solution permitting lower voltage at the same current output.**
3. **Increase in temperature decreases hydrogen overvoltage thereby facilitating the discharge of hydrogen ions and hence decreasing the current efficiency of zinc deposition.**
4. **Increase in temperature increases the rate of crystal growth causing coarse deposits. However, since increased solubility of salts and increased conductivity at higher temperature tend to decrease crystal size, they may partially counteract the tendency for growth of the nuclei.**

* * *

A typical example of a good quality zinc deposit is illustrated in Fig. 7, while quality defects resulting from impure electrolyte, high temperature, excessive gas evolution, as well as other possible causes are shown in microphotographs, Figs. 8 and

(*Please turn to page* 1445)

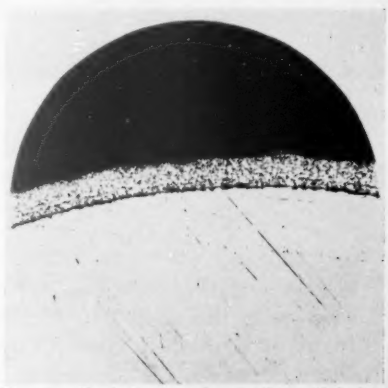

Fig. 7 — Typical example of the satisfactory quality of zinc deposit. Wire diam. .120 in., weight of coating 1.6 oz. per sq. ft. Etched in nital. Mag. 100X

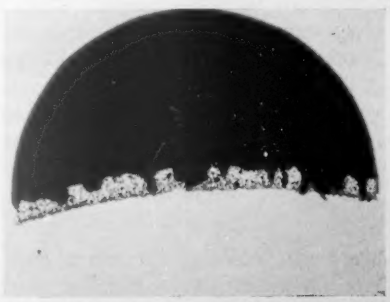

Fig. 8 — Traverse section of .109 in. diam. wire specifying .80 oz. per sq. ft. coating showing defective coating due to porosity, non-uniformity and coarse grain structure. Etched in nital. Mag. 100X

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Continuous Conveyorized Loop Processing — A New Concept in Rod and Wire Handling

by John Zouck
General Manager
Wirecrafters, Inc.
Towson, Maryland

The advantages of continuous, in-line strand treatment of rod and wire, as opposed to the batch method, have long been recognized by wire mill men. The outstanding features of the strand method are the possibility of a number of treatments without the necessity for in-between handling and the possibility of more uniform treatment. In considering the strand method it must be borne in mind that the factor which determines the combination of wire speed and length of treatment zone is the time required for treatment. Therefore, for constant time in treatment, the length of zone is directly proportional to the wire speed. This fact makes necessary either low lineal wire speeds or very long lines and immediately points up the principal disadvantage of the strand method of treatment. Continuous Conveyorized Loop Processing has been developed to eliminate this disadvantage while retaining the inherent advantages of the strand method of treatment.

* * *

The development of this system by **E. Jefferson Crum** is a very natural outgrowth of the rectangular package first described by Mr. Crum in a paper entitled "The Coreless Coil - A New Wire Handling System" and presented at the annual convention of The Wire Association in Chicago, Illinois, on October 15, 1957. In making this package, rod or wire is wound on a stationary inverted block and dropped, loop by loop, on a reciprocating pallet, so that precisely formed layers of wire are built up into a rectangular package as illustrated by Figure 1. Now, in the conveyorized loop treatment system,

John Zouck

This paper was prepared for presentation at the Annual Convention of The Wire Association on October 23, 1961, at French Lick, Indiana. The author is a graduate of the Massachusetts Institute of Technology. He learned to draw wire at the Sparrows Point plant of Bethlehem Steel Company, where he served in various capacities and was Metallurgical Supervisor of Rod and Wire Products until he joined the Marine Corps in 1942. He joined Johnson Steel & Wire Company in Worcester, Mass., in 1945 and the Maryland Fine & Specialty Wire Company in Cockeysville, Md., in 1946. After being in semi-retirement since 1948, he became affiliated with Wirecrafters, Inc., in January, 1961.

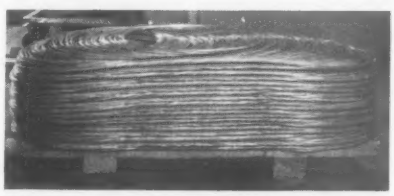


Figure 1

the wire is deposited in exactly the same manner, but instead of reciprocating, the receiving component (in this instance a conveyor) continuously moves in one direction. The wire thus deposited may be then conveyed through any desirable treatment.

* * *

Figure 2 illustrates the configuration of the wire on the conveyor. By varying the speed of

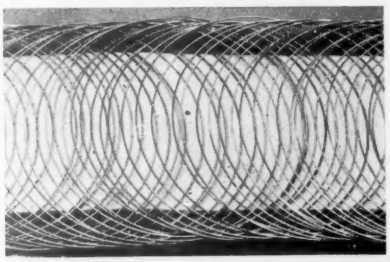


Figure 2

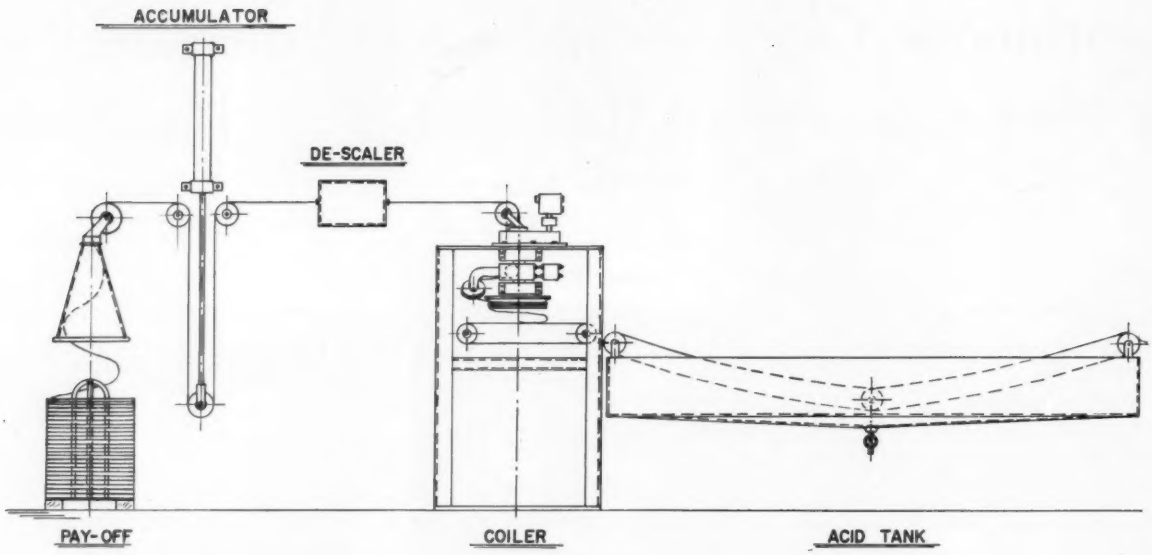
the conveyor with relation to the speed of the winding head, any desirable loop spacing may be obtained. The pattern thus assumed by the wire is quite stable. Wire in this form may be transferred from conveyor to conveyor, both belt and chain types, it may travel up and down inclines as great as 30 degrees and it may change direction in both vertical and horizontal planes, all without disturbing the pattern. This fact greatly increases the versatility of the system.

* * *

After the wire has been conveyed, in loop form, through all of the required processes, it is collected at the end in the customary geometrical pattern of the Crum Coreless Coil as described by Mr. Crum in the paper given by him in 1957 and shown in Figures 3 and 4 in the same paper referred to above. Figure 3 in this paper illustrates the pattern of the wire as collected on a stem. The precise manner in which the wire is collected assures orderly, tangle-free pay-off.

* * *

In order to indicate the relative space requirements of treatment zones used in wire mill processing, two possible cases are illustrated in Tables



CRUM. CONTINUOUS CONVEYORIZED CLEANING LINE

Figure 4

Figure 3

I and II. In Table I it is assumed that a theoretical production rate of 7500 pounds of 7/32″ wire is desired and that the required time in the treatment zone is 2 minutes. If this wire was wound at a lineal speed of 1000 feet per minute on a 36″ block and a loop separation on the conveyor of approximately 3 diameters was desirable, the conveyor speed would be 5 feet per minute. For a 2 minute treatment, this would require a treatment zone 10 feet in length. In order to achieve the same production using the strand method, it would be necessary to run 40 wires simultaneously at a lineal speed of 25 feet per minute and would require a treatment zone 50 feet in length. In addition to the saving in the length of the treatment zone, consideration must be given to the fact that in the loop system there is one pay-off and one collecting unit, whereas in the 40 wire strand system there are 40 pay-off and 40 take-up units. The saving in space here assumes sizeable proportions. In Table II the same assumptions are made as in the case of Table I except for the fact that the wire size is 1/16″, the loop size is 22″ and the desired production rate is 1800 pounds per hour. In this instance the savings in space are even greater.

TABLE I

7/32″ WIRE — 36″ LOOPS

	1 WIRE LOOP	40 WIRE STRAND
PRODUCTION RATE: LBS. PER HR.	7500	7500
TIME IN TREATMENT ZONE: MIN.	2	2
LINEAL WIRE SPEED: FT. PER MIN.	1000	25
CONVEYOR SPEED: FT. PER MIN.	5	—
LENGTH OF TREATMENT ZONE: FT.	10	50

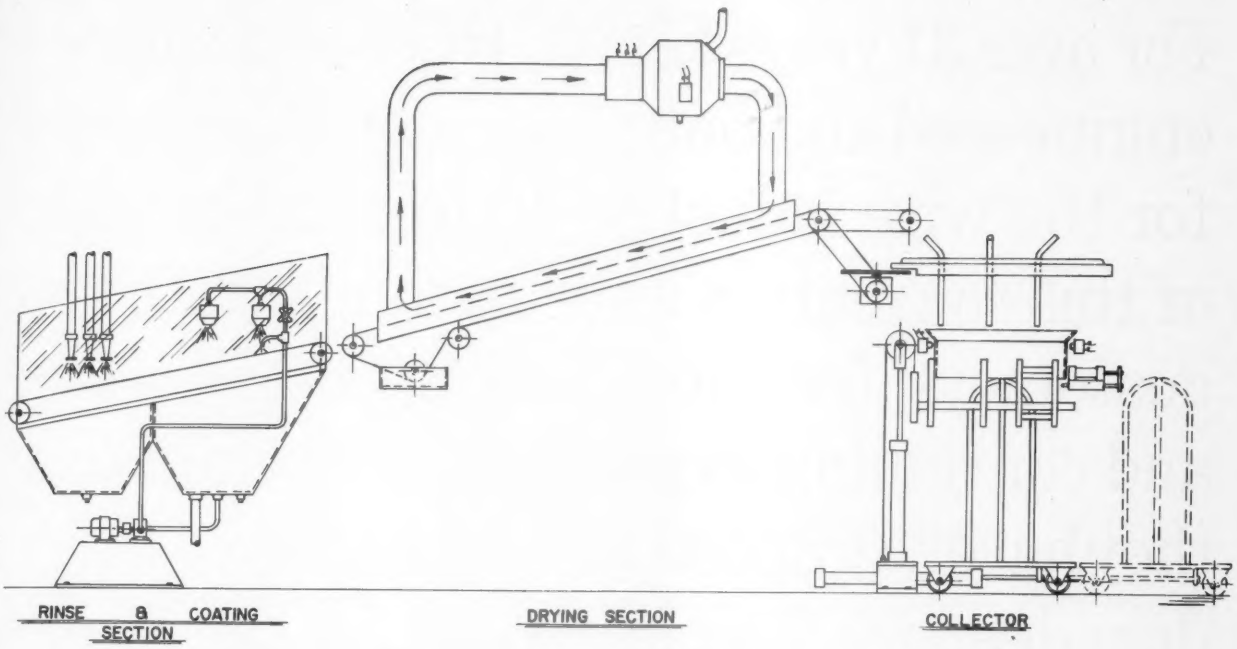
TABLE II

1/16″ WIRE — 22″ LOOPS

	1 WIRE LOOP	40 WIRE STRAND
PRODUCTION RATE: LBS. PER HR.	1800	1800
TIME IN TREATMENT ZONE: MIN.	1	1
LINEAL WIRE SPEED: FT. PER MIN.	3000	75
CONVEYOR SPEED: FT. PER MIN.	7.3	—
LENGTH OF TREATMENT ZONE: FT.	7.3	75

* * *

The first installation employing the Continuous Conveyorized Loop Processing system is a ferrous wire rod cleaning line. The elements in this line are shown schematically in Figure 4. In practice, the rod is paid off vertically through a cone and sheave arrangement into a mechanical descaler. In order to provide a shutdown without a break in the event of



SCHEMATIC ARRANGEMENT

Figure 3.

a snarl, an accumulator section is provided between the pay-off and the descaler. A loading and welding station is provided at the pay-off so that the operation is fully continuous. Adequate controls and safety devices are provided within easy access of the operator. * * *

The rod passes from the descaler to the coiler, which is an inverted stationary block arrangement. Wire holders mounted in contact with the block permit a sufficient number of wraps to remain on the block so that a full capstan effect is achieved. Then as each succeeding wrap is put on the block, one convolution is displaced and drops to a moving conveyor beneath the block in the pattern shown in Figure 2. The descaled rod thus deposited on the conveyor moves now through a 50% solution of commercial muriatic acid, a water rinse, a lime coating section and a drying section. Borax or any other suitable coating may be applied in place of lime. The drying section is a fully ducted forced hot air system and the rod is completely dry when it emerges.

* * *

From the center of the acid tank to the end of the dryer section, the rod has been travelling up a straight incline and has now ascended to a wire line height of approximately 130" from the floor. In order to provide orderly entry into the collector, a short levelling section of conveyor is inserted at this point. The rod drops, loop by loop, from the end of this conveyor into an orbiting set of guides which permit deposition of the loops in the customary geometrical pattern described heretofore. Elevator arms receive the coil as it is formed and constant delivery height is maintained through the use of photo electric cells. These "electric eyes" signal the elevator arms to gradually lower the coil, as it is formed, over a stem which serves as the final carrier. When a predetermined height or weight of package has been formed, the stem is automatically ejected in front of the collector. In the meantime, collecting pins have extended through the bundle former to accept the rod being continuously dropped. When the elevator arms automatically return to the "up" position, these pins retract and the cycle is repeated. The operator now has ample time to remove the full stem, replace this with an empty stem and return the transporter to the "in" position. This is all accomplished with no slow down in operation.

* * *

The cleaning line just described was originally designed for a wire drawing operation with an annual capacity of approximately 15,000 tons of 7/32" wire rods. The principal requirements for the line as laid down by the owner were as follows:

1. **Low capital investment**
2. **Location in available and limited space**
3. **Minimization of acid fume problems**
4. **Minimization of acid disposal problems**
5. **Low operating cost**

* * *

An analysis of available costs on installations of conventional batch cleaning lines indicates

(*Please turn to page* 1452)

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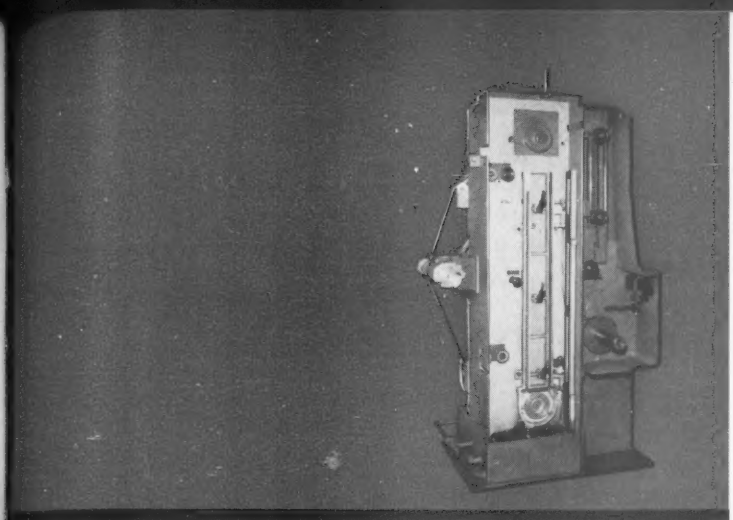

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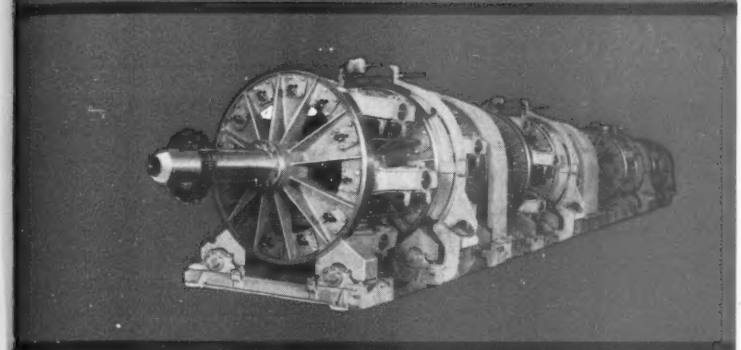

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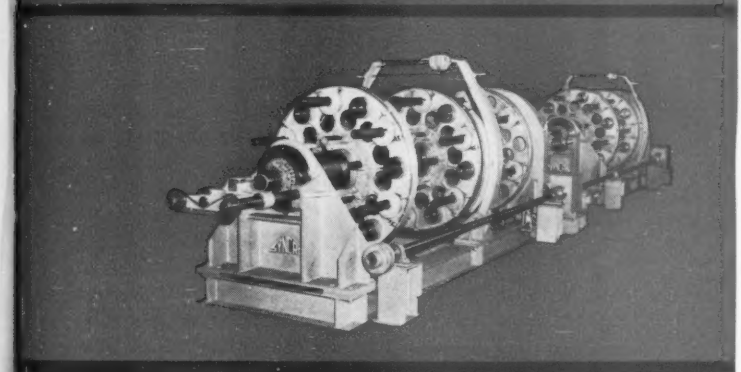

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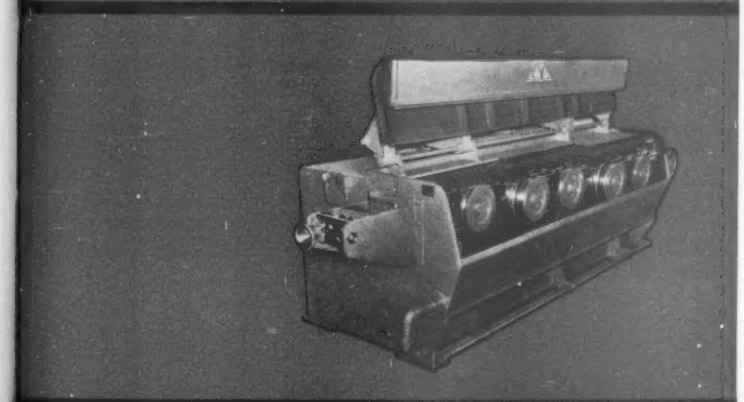

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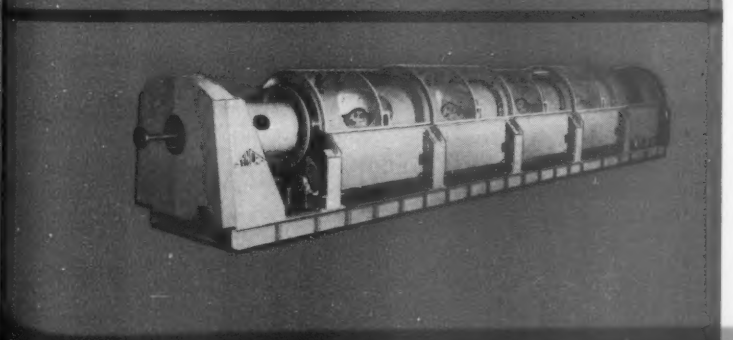

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Wire Coating with Polyethylene Resins: Improvement in Extrudate Quality by Using Sensitive Instrumentation

by Dr. F. H. Skewis
Polychemicals Department
Polyolefins Division, Technical Services Laboratory
E. I. du Pont de Nemours & Company
Wilmington, Delaware

ABSTRACT

Extrudate quality, here defined as the temperature and pressure uniformity of an extruded plastic melt, can have a marked effect on the quality of the finished product. Pressure variations result in changes in product dimensions. Effects of temperature are more difficult to demonstrate. Presumably, however, they could lead to localized stress concentrations having an adverse effect on physical properties. Thus uniform extrudate quality is highly desirable in any extrusion operation.

Our Research Division has recently developed sensitive instrumentation for continuously recording the temperature and pressure of an extruded plastic melt. These instruments have been used extensively on extruders while coating wire with polyethylene resins. From these studies the effect of a number of process variables on extrudate quality have been determined while producing various wire constructions at low, intermediate, and high output rates.

Dr. F. H. Skewis

This paper was prepared for presentation at the Annual Convention of The Wire Association on October 24, 1961, at French Lick, Indiana.

The author graduated from the University of Washington in Seattle in June, 1950, with a Ph.D. in Chemistry. He then joined the Du Pont Company, Polychemicals Department, at Belle Works near Charleston, W. Va. In 1956, after six and one-half years in the Technical Section at Belle Works, he was assigned to the Sales Division in Wilmington at the Polychemicals Technical Services Laboratory as a Technical Representative. A major portion of his time at this location has been devoted to processing of thermoplastics in wire coating applications.

Prediction of the performance of single screw plasticating extruders in terms of the **output** per unit of time has been the subject of considerable study (1, 2). These studies have enabled us to calculate delivery rate of extruders under a wide variety of conditions. The performance of these same extruders in terms of the **quality** or uniformity of the plastic melt delivered in a particular process has not been studied as extensively. Recently, however, sensitive instruments have been developed to measure continuously and record temperature and pressure fluctuations in extruded plastic melt (3). These instruments have been used to determine the quality, or temperature and pressure uniformity, in both nylon and polyethylene film extrusion (4). In the past year we have applied this sensitive instrumentation to wire coating studies in our Technical Services Laboratory. In addition, it has been used in a number of wire processing plants to determine causes and cures for extrudate quality defects in their equipment.

* * *

The temperature and pressure uniformity of an extruded plastic melt can have a marked effect on the quality of the finished product. Pressure variations result in undesirable changes in product dimensions. Effects of temperature variability are more difficult to demonstrate. Presumably, however, they could lead to localized stress concentrations having an adverse effect on physical properties. Uniformity becomes particularly important in extrusions requiring close dimensional tolerances such as the coating of wire and paper and the manufacture of film. Thus it becomes important to measure not only the level, but also the variation of temperature and pressure of the plastic melt as it leaves the extruder screw and enters the die.

* * *

Melt thermocouple and pressure gauges for measuring the average temperature and pressure of the extruded melt were first introduced to the industry in 1955 (5). They have gained wide acceptance and have become standard components of extruder instrumentation. Although the average level of these variables is important in the control of extrution, point to point variation from the average can give information of equal or greater importance in determining reasons for product quality changes.

* * *

The sensitive instruments, in conjunction with suitable amplifying and high speed recording equipment, permit the measurement of temperature variations of less than one degree Fahrenheit and pressure changes in the range of two pounds per square inch. They were originally used by Du Pont for studies where the maximum rate of response and sensitivity were required.

Pressure Measurements

In these studies, two types of commercially available, rapid response pressure transducers were used. Both of them use a strain

gauge to convert the applied pressure into an electrical signal which is amplified and recorded. Because of the temperature sensitivity and upper temperature limit of the strain gauge sensing elements, they cannot be placed in close contact with the melt stream. Thus the pressure must be transmitted by some type of a remote control coupling. Both mechanical and hydraulic types are used and operate with equal sensitivity as far as we have been able to determine in these studies.

* * *

The first type used was a Baldwin SR-4 gauge (6) shown in Figure 1. This instrument uses a hydraulic coupling of silicone grease for transmission of pressure from the melt stream to the strain gauge. This had the same difficulties of contamination, holdup, and possible plugging encountered in the use of the original grease-filled Bourdon gauges.

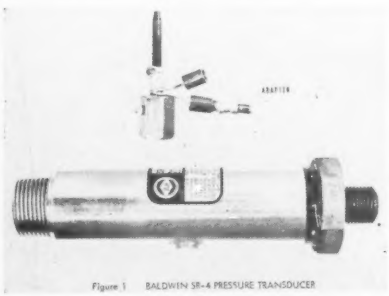


Figure 1 BALDWIN SR-4 PRESSURE TRANSDUCER

The newer gauges, represented by the 'Dynisco' type gauge (7) shown in Figure 2, use a mechanical coupling for transmitting pressure from the melt to the strain gauge. A

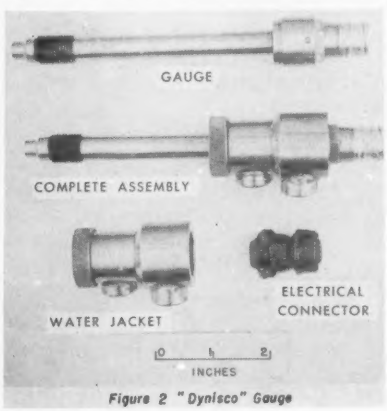


Figure 2 "Dynisco" Gauge

metal diaphragm at the tip of the gauge is in contact with the melt. Pressure of the melt against the diaphragm is transmitted by a metal rod to the sensing element at the rear of the gauge. The use of a diaphragm eliminates the problems of grease contamination, holdup, and plugging. However, considerable care must be used in installation since the diaphragm is easily damaged.

Temperature

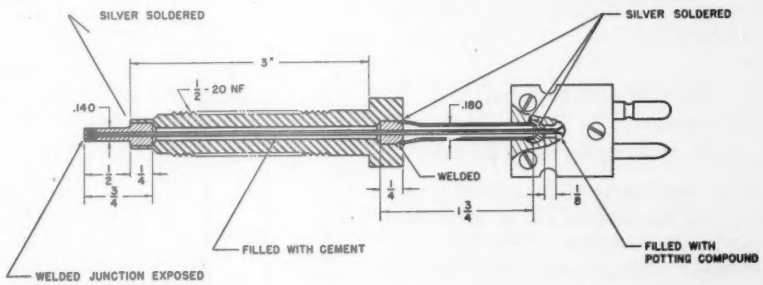
Melt thermocouples normally used in extrusion have a metal shield protecting the thermocouple from mechanical abuse. In addition, the shield also prevents the thermocouple from sensing rapid changes in melt temperature because it acts as a heat sink. Exposing the thermocouple junction directly to the melt stream and insulating it from the metal sheath results in a much faster and precise response. An unshielded thermocouple of the type used in these studies is illustrated in Figure 3. A comparison of temperature recordings from the two types of thermocouples is given in Figure 4.

Amplifying and Recording Equipment

A number of systems are available for amplifying and recording electrical signals from thermocouples and strain gauges. In our work the use of Sanborn equipment has proven very satisfactory from a standpoint of accuracy, response, and convenience.

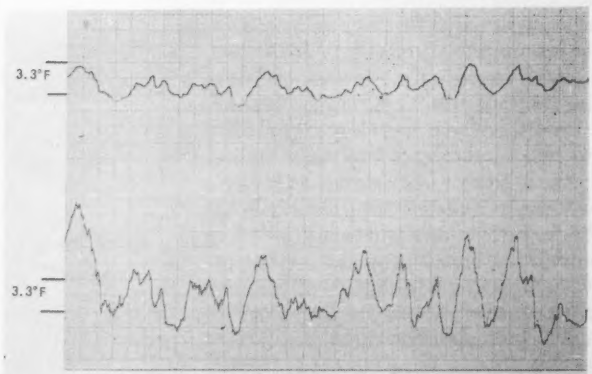
* * *

Our system is shown in Figure 5. The thermocouple and pressure transducer are here mounted in an extruder adapter. The thermocouple is connected through a Sanborn low level preamplifier to one channel of the recorder. The pressure transducer is connected through a Sanborn carrier preamplifier to the second channel of the recorder. In addition, a microswitch actuated by rotation of the extruder screw drive shaft may be connected for marking screw revolutions simultaneously with the pressure and temperature recordings. We are currently working on an additional recording for wire coating studies which will be a



UNSHIELDED THERMOCOUPLE

FIGURE 3



MELT TEMPERATURE FLUCTUATIONS: Measured simultaneously with a standard shielded thermocouple (upper curve) and with an insulated unshielded thermocouple (lower curve). Sensitivity equals 3.3°F per centimeter.

FIGURE 4

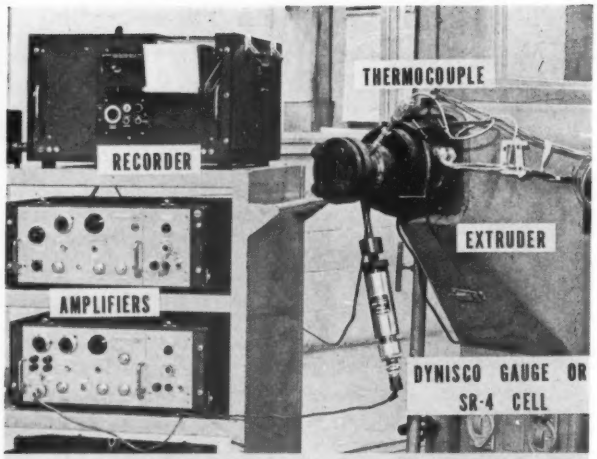
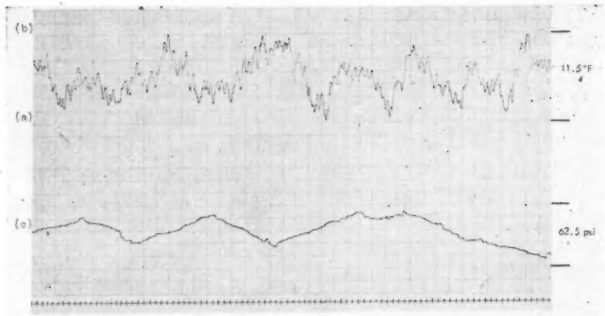


FIGURE 5 EXTRUDER INSTRUMENTATION



Typical Recording of Temperature and Pressure Fluctuations with a two pen Sanborn Recorder

Top: Temperature
Center: Pressure
Bottom: Screw revolution

FIGURE 6

tachometer generator signal from the capstan or coated wire take-up unit. Since variations in wire coating dimensions may frequently be caused by small variations in take-up equipment speed, such a signal would be very useful. A typical recorder chart is illustrated in Figure 6 showing a continuous recording of both temperature and pressure and fluctuations of these variables.

Use of the Sensitive Instruments in Wire Coating with Polyethylene Resins

The instruments described above have an obvious place in Research efforts devoted to understanding various extrusion operations. In our wire coating work a large variety of wire constructions are made under widely varying conditions. The majority of coatings are produced from our Alathon® polyethylene resins. From a process and product development standpoint, use of the sensitive instruments has made a large contribution to our understanding of wire coating. Our ability to reproduce experiments, evaluate resins, take meaningful data, and detect causes of trouble have all been improved. Our studies have covered a broad range of conditions resulting in a wide range of temperature and pressure variations. Figure 7 indicates the melt uniformity attainable in wire coating. In this particular case, 10 mils of an "Alathon" polyethylene wire coating resin was being applied to #22 AWG solid copper wire at a rate of 2100 ft./min. Output rate was approximately 55 lb./hr., rather low for the 3¼" extruder used in these studies. Maximum variation was 25 psi at a crosshead pressure of 3000-3500 psi. Temperature variation was negligible.

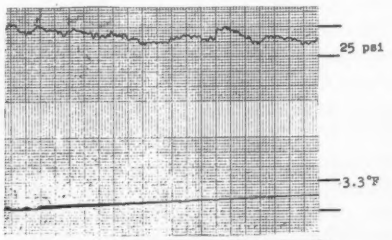


Figure 7. Good Extrudate Quality - 10 mils polyethylene on #22 AWG solid copper wire at 2100 ft./min.

* * *

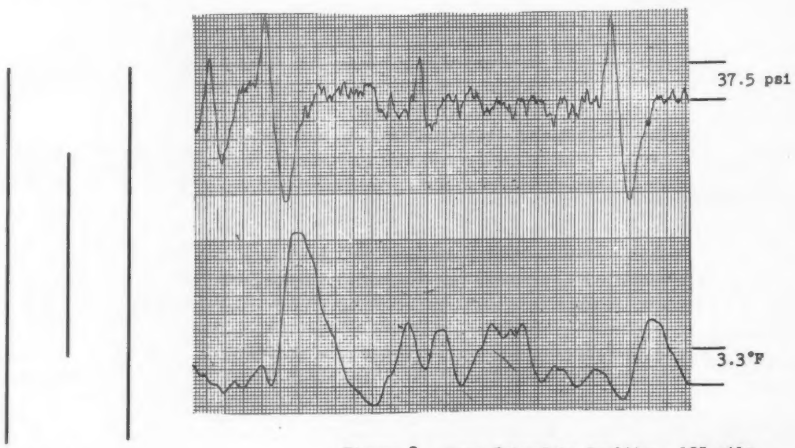


Figure 8. Poor Extrudate Quality - 125 mils of polyethylene on #14 AWG solid copper at maximum extruder output.

STANDARD WIRE COATING LINE WITH SOURCES OF VIBRATION

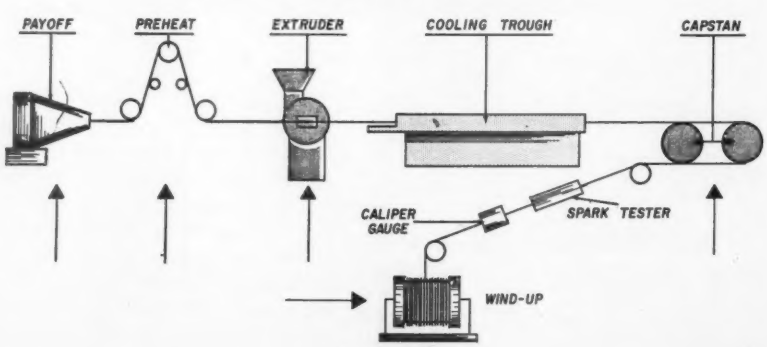


FIGURE 9

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Figure 8, on the other hand, illustrates the variation that can be experienced under improper operating conditions. Here 125 mils of polyethylene was being applied to #14 AWG solid copper wire at 120 ft./min., 240 lb./hr. or almost maximum extruder operation. Pressure variations up to 250 psi were being encountered with temperature fluctuations as great as 17°F. With the proper choice of operating conditions, we were able to eliminate the surging and considerably improve the temperature variability.

* * *

Thus a wide range of extrudate quality levels can occur in wire coating. Our objective was to study a number of such cases to determine what measures would be required to obtain the ultimate in quality when producing a wide variety of constructions.

Application of Thin Coatings to Small Diameter Wires at High Speeds

The first extensive application of the sensitive instruments involved their use in high speed, thin wire coating studies. This involved study of the variables important in production of smooth ten mil coatings on #22 AWG solid copper wire at speeds to 2500 ft./min., the maximum of our equipment. When the sensitive instruments became available, we made it standard practice to use them in these runs.

* * *

The wire coating line is illustrated in Figure 9. This line is equipped with a 3¼" Davis-Standard extruder having a 20/1 length to diameter ratio and a variety of screw designs. A standard 90° crosshead is used with provisions for equalizing melt flow. The line is equipped with a Flyer type payoff, a preheater of our own design, a 30 foot quench trough, 30" dual capstan, and a high speed take-up.

Wire Vibration

One of the most frequent difficulties encountered in our early studies was that of wire vibration. The most common sources of this difficulty are illustrated in Figure 9. Elimination of vibration substantially raised the rate at which we could produce smooth thin coatings. Figure 10 gives a comparison of the line under conditions of severe vibration with the same system after alterations had been made to produce smooth wire flow. As can be

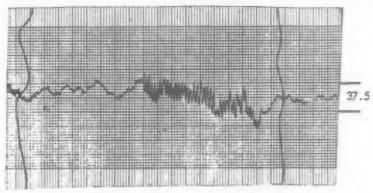

Figure 10. Wire Vibration - Pressure Trace
1 cm = 37.5 psi
chart speed 0.5 mm/sec.

seen, the major effect was to reduce pressure fluctuations in the crosshead. These alterations included purchase of a new Flyer type payoff, increased support and better centering of the wire going into the crosshead, leveling of the crosshead, and changes in the take-up reels.

* * *

An additional difficulty was encountered in the early studies, that of wire slippage on the capstan. This was encountered most frequently with low density polyethylene containing carbon black, although in later work the same problem has been encountered with high density resins probably due to their harder surface. As the coated wire begins to slip on the capstan, it slows down. Since the wire exerts a considerable pumping action in the die, a decrease in speed at the same extruder output rate results in a substantial pressure increase. This is observed on the continuous recorder as a series of pressure loops as shown in Figure 11.

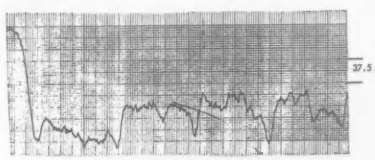

Figure 11. Capstan Slippage - Pressure Trace
1 cm = 37.5 psi
chart speed 0.5 mm/sec.

Attainment of Equilibrium in Wire Coating Studies

In determining the effect of production variables in wire coating studies, it is important that the data be as precise and meaningful as possible. The sensitive instruments have given us the means for gaining the desired degree of precision. It is not unusual for instance, in thin wire coating studies at pressures of 3000-3500 psi to make repeat runs with a pressure variation of 25 psi. These same instruments have an additional advantage: They insure the taking of data under equilibrium conditions. This is important where a series of runs are being made and it is necessary to stop between each run for setup changes. An example of the approach to equilibrium conditions is illustrated in Figure 12.

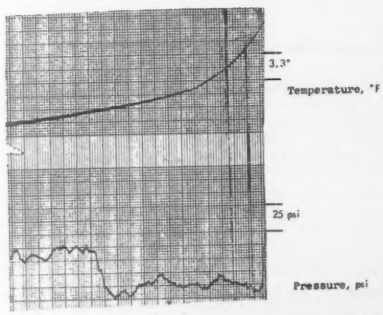

Figure 12. Approach to Equilibrium Using Sensitive Instruments.

Parallel Thermocouple for Extruder Control

Extruders on the market today have a variety of control systems. In the Technical Services Laboratory, the time-proportioning type is the most commonly used. However, we do have some extruders equipped with the saturable core reactor type of controller. These are actuated by thermocouples located either next to the barrel liner or just under the heater band. While the deep-well type has the advantage of being closer to the molten plastic inside the barrel liner, the shallow location gives more rapid on-off cycling of the heater element and more uniform heat input.

* * *

In another area of plastic processing, injection molding, Du Pont devised a system of parallel thermocouples to furnish very close dimensional tolerances in molded parts. The deep thermocouple, wired in parallel with one just under the heater band, gives the advantage of both good control and sensing of the melt temperature at the barrel liner.

* * *

Accordingly, parallel thermocouples were installed in our 3¼" wire coating extruder. Although somewhat more rapid cycling of the heater bands was noted, the extru-

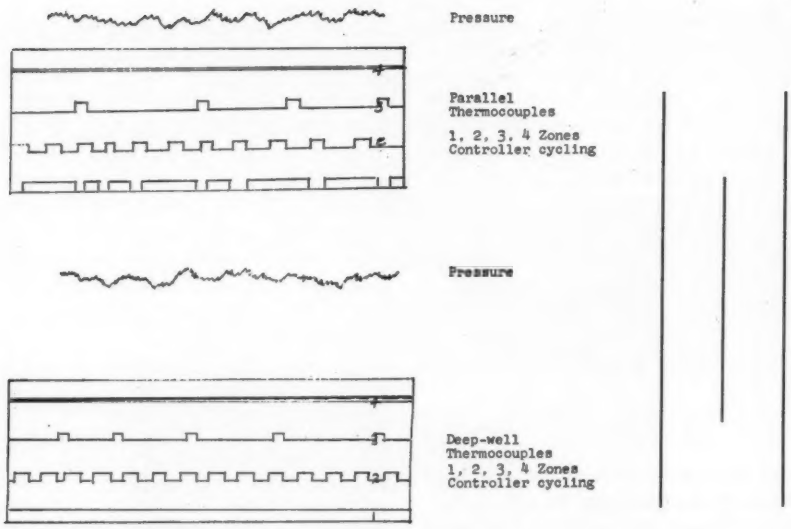

Figure 13. Parallel Thermocouples vs. Deep-well Design. Pressure and event recorder traces.

date quality delivered to the wire seemed to be about the same. A typical recording for this work is given in Figure 13. To be really effective, parallel thermocouples should be used with controlled wattage on the heater bands. This has been demonstrated recently in a paper published by Ramsey at John Royle & Sons (8). Using parallel thermocouples and controlled wattage, he was able to reduce barrel temperature variations from ten to one and a half degrees Fahrenheit. We have not yet had an opportunity to study wattage control in our wire coating system to determine its effect on temperature and pressure uniformity of the plastic melt.

Comparison of the Quality of Plastic Melt Delivered by Vinyl and Metering Screws

The next step in our high speed, thin wire coating program was to determine the effect of changes in extrudate quality on wire coating smoothness. Of primary concern was the comparison of vinyl and metering screws for various types of operation. Many of our customers use the vinyl screw, and it is to our interest to be able to define conditions for optimum operation of this design. A series of runs was made with vinyl and polyethylene metering type screws, applying 0.010" of "Alathon" 4, BK-30 to #22 wire at 2100 ft./min. In order that changes in surface of the wire coatings produced might be more easily compared, a die was chosen which gave somewhat rough coatings. The results of these studies are included in Table I. From these results, several conclusions were drawn:

TABLE 1

EXTRUDATE QUALITY DURING HIGH SPEED THIN WIRE COATING

"Alathon" 4, BK-30: Ten mils on #22 wire
2100 ft/min. - 50-60 lbs/hr. extruder output

Experiment	Average Pressure Variation, psi	Maximum Pressure Variation, psi
Vinyl Screw; 500°F. Low Rear Barrel	33	50
Vinyl Screw; 500°F. Level Barrel Profile	73	100
Vinyl Screw; Cooled to 90°F.; 500°F.; Low Rear Barrel	29	30
Polyethylene Metering Screw; 500°F.; Low Rear Barrel	21	30
Polyethylene Metering Screw; 500°F.; Level Barrel Profile	39	40

(1) Temperature variations substantially larger with a vinyl-type screw.

1. **With the differences in extrudate quality observed here, the maximum improvement in smoothness of the coatings produced with the two screws was in the 10-15% range.**
2. **The best extrudate quality, measured by pressure variation in the melt delivered to the wire coating crosshead, was observed with the polyethylene screw while operating with a low rear barrel temperature.**
3. **The vinyl screw with some water cooling is capable of delivering a melt almost equivalent to the best observed with the metering type under the conditions required in this work. The vinyl design, however, is considerably more sensitive to changes in processing conditions.**
4. **With either of the screws tested, pressure uniformity of the extrudate was best with a low rear barrel temperature on the extruder.**
5. **Temperature variations at this output level with the 3¼" extruder were negligible.**

The Importance of Extrudate Quality in Extruded Plastic Melts

These measurements of temperature and pressure uniformity are very interesting, but to be useful they must be correlated with product quality. The effect of pressure variation in giving a product with variable uniformity is easily predictable. The extent of this variation in film extrusion has been demonstrated in the work of Kessler, Bonner, Squires, and Wolf (4). Their results are illustrated in Figure 14. Similar studies have been carried out in wire coating and are included in Figure 15. In both cases,

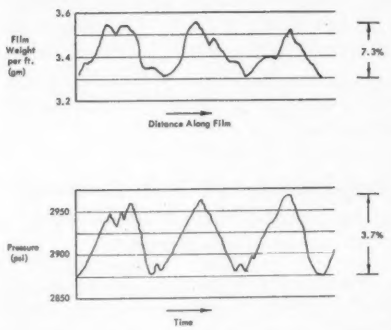

FIGURE 14 - CORRELATION BETWEEN PRESSURE FLUCTUATIONS AND OUTPUT FLUCTUATIONS

there is an obvious one to one correlation between pressure and output.

* * *

The effect of temperature fluctuations is difficult to demonstrate, since changes required to produce various levels of temperature uniformity also result in changes in pressure. However, temperature fluctuations as high as 15-20°F have been observed in these studies. The resulting viscosity changes are of sufficient magnitude to result in substantial variations in the flow of the resin from the die. In addition, variation in temperature may result in frozen-in stresses in the wire coating with variation in physical properties such as tensile, stress crack, shrink-back, etc.

Production of Various Wire Constructions at Intermediate and High Output Rate

Application of 0.010" polyethylene coatings to #22 AWG solid copper wire required only a small fraction of the output available from the 3¼" extruder used in this

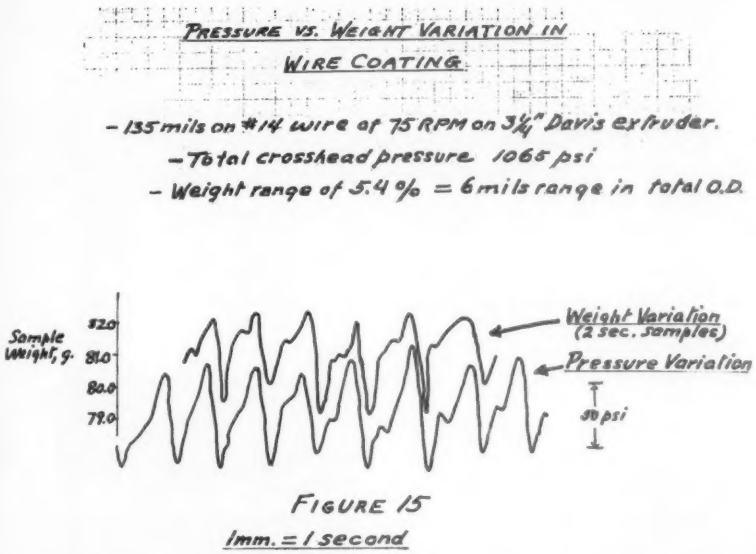
PRESSURE VS. WEIGHT VARIATION IN WIRE COATING
- 135 mils on #14 wire at 75 RPM on 3½" Davis extruder.
- Total crosshead pressure 1065 psi
- Weight range of 5.4 % = 6 mils range in total O.D.
Sample Weight, g.
82.0
81.0
80.0
79.0
Weight Variation (2 sec. samples)
Pressure Variation
90 psi

FIGURE 15

1mm. = 1 second

work: 50-60 lb./hr. of a total capacity of 250 lb./hr. The next step in our program was to determine the performance of this machine at higher output with heavier wire constructions. Two output ranges were selected: 100 to 150 and 200 to 250 lb./hr. Wire constructions included 0.030" on #14, 0.045" on #14, 0.125" on #14 AWG solid copper wire, and 0.125" of polyethylene on #4-7 strand aluminum cable.

* * *

These studies showed that marked temperature and pressure fluctuations could occur at the intermediate and high output rates with the various constructions. Pressure changes representing as much as 15% of the total head pressure were observed, with temperature fluctuations in one case reaching 14°F, as shown in Table 2. Since these levels of variation were high enough to result in adverse effects on product quality, a series of studies was carried out to determine what measures could be taken to improve melt uniformity.

TABLE 2

Typical Pressure and Temperature Fluctuations - Various Wire Constructions

Wire Constructions	Wire Rate ft/min.	Pressure psi	ΔP psi	ΔT °F
30 mils on #14	450	1445	110(7.6)	3
45 mils on #14	325	1500	107(7.1)	3
125 mils on #14	120	1065	165(15.5)	6-14
125 mils on #4-7 strand aluminum	67	1075	15	3

Pressure variation from 7 to 15% except for tubing die example.

The Effect of Output Rate

Delivery of melted plastic of good quality at high rates is important in any extrusion operation. Otherwise the extruder, perhaps the most expensive piece of equipment in the processing line, becomes the limiting factor in production rate. In general, quality in terms of both temperature and pressure uniformity tends to deteriorate as the rate increases as shown in Table 3 for two high molecular weight wire coating resins. In the first case, the

TABLE 3

Extrudate Quality vs. Production Rate

Wire Constructions	Rate ft/min.	ΔP	ΔT
0.045" on #14 solid copper	325	21	1.6 - 2.3
0.045" on #14 solid copper	525	19	2.7 - 4.6
0.045" on #14 solid copper	325	18	2.6 - 3.6
0.045" on #14 solid copper	525	45	9.2 - 11.6

deterioration was not large and occurred mainly in temperature variation. In the second case, severe changes in both temperature and pressure fluctuations occurred. Eventually, as output increases, a point is reached at which melt fracture occurs, and production of a quality product becomes impossible. This is shown in Figure 16.

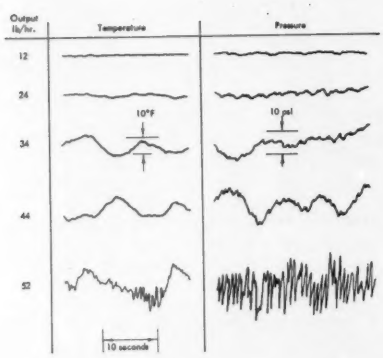

FIGURE 16 - EFFECT OF THROUGHPUT ON TEMPERATURE AND PRESSURE UNIFORMITY

Extruder Temperature Profile

The fact that the extruder barrel profile can have a marked effect on extrudate quality has been known for some time. Extrusion processors are aware of this and will normally use temperature controller settings which they have found the most suitable in their equipment. Changes in profile are among the easiest known methods to improve quality, since they require no investment and only enough time to demonstrate their effect.

* * *

In wire coating studies, barrel temperature profiles were also found important. Use of the sensitive instruments furnished information quickly on the results of each change. Their use in thin wire coating studies has already been noted. The effect of changes in barrel profile for the heavier constructions is shown in Table 4. Improvements in both temperature and pressure uniformity were noted both with the 45 and 125 mil coatings on #14 AWG solid copper wire at the indicated output. In these studies, the change was from a low rear barrel which had given good results with thin wire coatings to the so-called "hump-back" profile.

* * *

Pressure surging was occasionally encountered in these studies. Increasing the stock temperature with the same barrel profile reduced the amplitude and frequency of the surging but did not eliminate it. The "hump-back" profile resulted in elimination of the surging on our 3¼" extruder. It should be emphasized, however, that extruders of various sizes and designs may react in different ways to changing temperature profiles. The sensitive instruments offer the fastest possible approach to the profile required for the resin being used.

Screw Design

The design of extruder screws is extremely important in delivery of a melt having a high degree of temperature and pressure uniformity.

TABLE 4

Effect of Temperature Profile on Extrudate Quality

Rear	Center Rear	Center Front	Front	Stock °F	Screw RPM	△P	△T
0.045" of "Alathon" 4, BK-30 on #14 AWG solid copper at 325 ft/min.							
350	420	420	420	431	39	107	3.1
300	350	450	430	424	37	70	2.1
0.125" of "Alathon" 4, BK-30 on #14 AWG solid copper at 135 ft/min.							
330	390	390	390	390	70	44	8.5
300	350	450	425	395	70	15	6.9

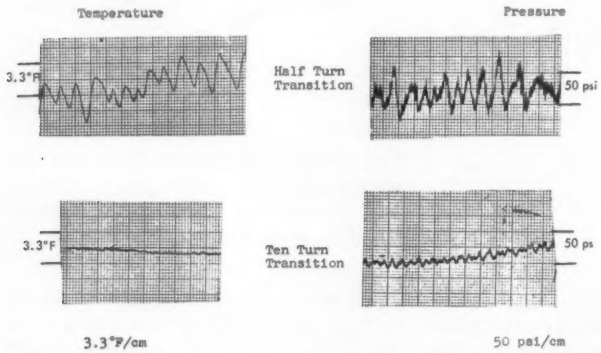

Figure 17. Performance of extruder screws having gradual and sudden transitions. chart speed 0.5 mm/sec.

TABLE 5

Operation of the Vinyl and Metering Screws With and Without Screw Cooling

Screw	Cooling	Wire Rate ft/min.	△P psi	△T °F
Neutral Vinyl	None	800	145 (7%)	15
Neutral Metering	None	800	48 (2%)	3.7
Vinyl	Full - 100°F	600	5	1.7
Vinyl	Full - 150°F	675	50	6.6
Vinyl	Feed Only - 100°F	770	78	11.2
Metering	Full - 100°F	600	5	0
Metering	Full - 150°F	635	29	3.0
Metering	Feed Only - 100°F	550	45	5.6

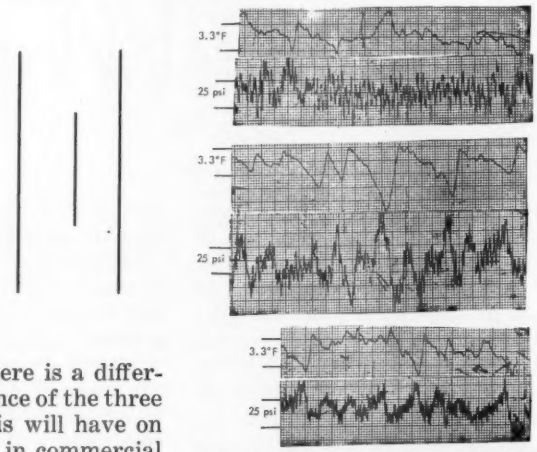

Figure 18. Extrudate Quality Variation with Die Design. 3/64" "Alathon" 4, BK-30 on #4-7 strand Aluminum at 185 ft/min.
Die #1: 62° inlet; 0.9 inch final 6° taper.
Die #2: 62° inlet; 0.9 inch parallel land.
Die #3: 62° inlet; 0.33 inch parallel land.

The effect of metering zone channel depth has been reported previously. Decreasing the depth in this section of the screw results in a marked improvement in melt uniformity at the same output rates.

* * *

The transition between the feed and metering zones is also important. The results obtained in extrusion of polyethylene strip from a 2" extruder with two different screw designs are shown in Figure 17 by way of example. The only difference in the two designs was in the length of the transition, (½ vs. 10 turns). A marked quality improvement was noted with the gradual transition screw in both pressure and temperature uniformity.

Die Design

The sensitive instruments also offer a method of study of die design. We have done a limited amount of work in this area on heavy coatings. This was done with a series of dies of different configurations. The only feature they had in common was design for pressure application of 3/64" coatings of "Alathon" 4, BK-30. The coating was applied at a speed of 185 ft./min., requiring 61 RPM on the extruder at a stock temperature of 450°F. The results are shown in Figure 18. Obviously there is a difference in the performance of the three dies. What effect this will have on the results observed in commercial production by the wire and cable processor is not yet known. However, follow-up on this work is planned.

Screw Cooling Studies in Wire Coating — Metering and Vinyl Screws

Processors are now becoming increasingly interested in improved temperature and pressure uniformity of plastic melts. Thus methods of attaining improved extrudate quality with existing screws will become increasingly important in customer service work. As mentioned in the thin wire coating study, water cooling is commonly used in vinyl screws producing polyethylene wire coatings, since it improved melt quality. Occasionally one finds a water cooled metering screw in service. This is particularly true in high speed thin wire coating where cooling results in marked improvement in wire coating smoothness. For these reasons, a series of studies have been carried out to determine the effect of water cooling of both polyethylene and vinyl screws when applying heavy coatings of polyethylene at relatively high output rates. The results of these are illustrated in Table 5. They may be summarized as follows:

1. **Although a 30-40% reduction in output is experienced, plastic melts having a very high degree of uniformity can be produced under the proper conditions of cooling with both the vinyl and metering screws.**
2. **At high output with no screw cooling, the metering screw gives markedly better melt quality than the vinyl design.**
3. **Melt uniformity of the vinyl screw can only be held at acceptable levels by cooling throughout its length.**
4. **Attempts to improve both uniformity and output of the vinyl and metering screws by modified cooling methods were unsuccessful.**

Thus, if a very high degree of uniformity is required with existing screws, screw cooling will help attain this objective, but only at a reduction in output. In the case where thin coatings are being applied at high speeds, output requirements may be well below those of the extruder, and cooling offers no produc-

(*Please turn to page* 1468)

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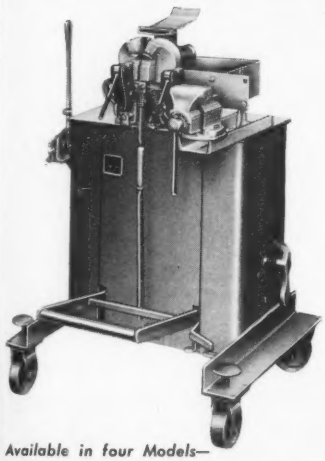

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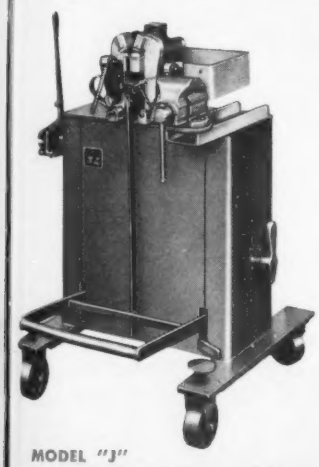

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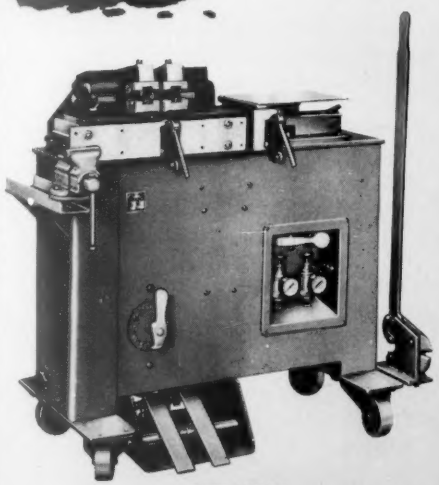

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Production and Characteristics of Chemically Purified Hydrogen Precipitated Copper Powder

by Jack F. Whitaker, President
Whitaker Cable Corporation
Kansas City, Missouri

This paper was prepared for presentation at the Annual Convention of The Wire Association October 24, 1961, at French Lick, Indiana.

As all users of copper must at some time or other wonder if they can reduce their cost of material, so it was with Whitaker Cable. A very small electrolytic tank house was constructed and operated during the period from January, 1950, until the summer of 1952. The tank house could produce 30,000# of good cathodes a month.

* * *

Normally, the anodes used in the electrolytic process have a copper content in excess of 95%, which means the material fed to the casting furnaces must be high grade. Handling impurities of any marked degree became expensive.

* * *

We had run into the problem of impurities and had made an electrolytic layout for a plant to produce 600,000# per month of cathodes. We discussed with Mr. Properzi, of Milan, Italy, the inventor of a machine for the continuous casting of aluminum into a ¼" rod, the possibility of making such a machine for copper. At this time we came across a process called the "Chemico Technique", which had been developed jointly by the Chemical Construction Corporation, a wholly owned subsidiary of American Cyanamid Corporation, and Sherritt Gordon Mines, Ltd. of Edmonton, Canada. The Lincensor of this process is the Chemetals Corporation of New York.

* * *

This chemical process permitted the use of any type of copper-bearing scrap and/or copper concentrates. This broadened the range of usable feed materials to such an extent that it was decided we would go this way rather than the electrolytic process route.

* * *

A common phrase in the chemical industry is, "Seven years from test tube to tank car." This phrase definitely applies in this instance. We made our first small batch of copper powder on July 4, 1953 and not until the fall of 1960 did we feel we had a sound process operating – Seven years and a lot of money later.

* * *

I shall not bother you with our trials and tribulations during this period except to say – we had 'em.

* * *

The various steps of the process cannot be discussed in complete detail because of limited time, but the essential operations will be covered.

Description of Process

The process used at the Whitaker Metals plant consists of five separate steps. These steps are:

1. Leaching
2. Purification
3. Reduction and Powder Washing
4. Drying, Crushing and Classifying
5. Standards and Controls

Leaching

Leaching is carried out at atmospheric pressure and at temperatures of 100° to 140°F. A solution containing ammonia, carbon dioxide, water and some dissolved copper is used for leaching. The leaching rate depends upon the temperature, velocity of leaching solution past the scrap, and chemical and physical characteristics of the scrap.

* * *

It is obvious that the design of the leaching vessel depends to a great extent upon the physical characteristics of the scrap. It is unlikely that any one vessel would be designed to handle any and all types of copper-bearing scraps presently on the market. However, a plant to handle a great variety of copper-bearing materials is definitely within the scope of the process. Usually leaching vessels are designed to handle two or three kinds of scrap, depending upon the economics of the operation as determined by scrap prices, availability, etc.

* * *

Briefly, the action of the leaching solution is this: dissolved cupric copper leaches metallic copper from the scrap to form cuprous copper in solution. A portion or all of the leached solution must be oxidized using air or oxygen to convert cuprous copper again to the cupric state so leaching may continue.

* * *

It has been found that zinc in the scrap dissolves at about the same rate as copper. The zinc content in solution is maintained at a fixed level by treating a part of the liquor in a zinc removal unit, or by dissolving zinc scrap as required. The zinc content required is determined by the leaching and the reduction conditions.

* * *

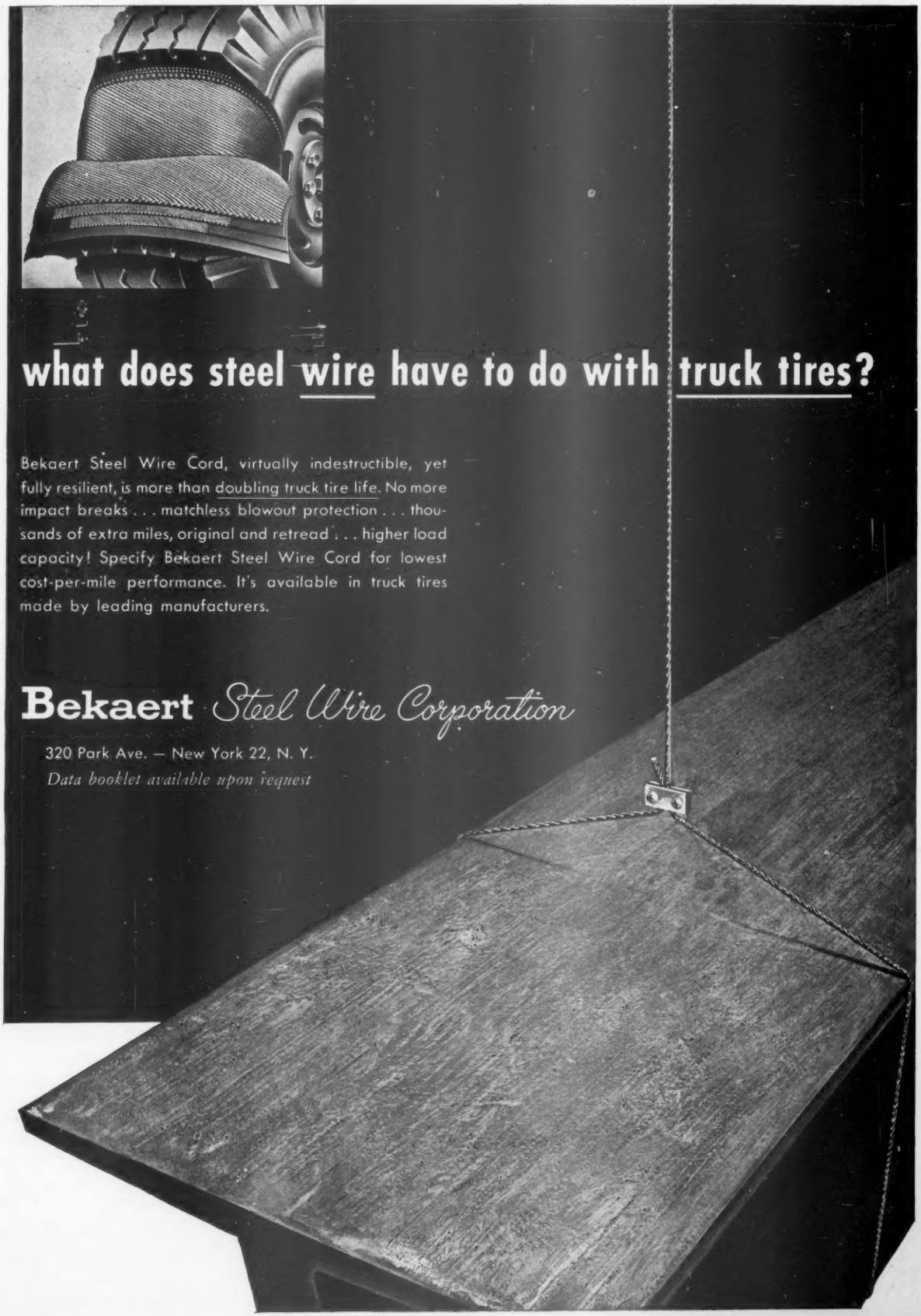
Other metals in the scrap, such as lead and tin, are only slightly soluble and may be recovered in the leached residue as oxides and carbonates.

* * *

The leached solution is held at or near atmospheric pressure and the normal leaching conditions present no corrosion problems. Therefore, equipment is of carbon steel construction.

* * *

A typical range of composition of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Bekaert Steel Wire Cord, virtually indestructible, yet fully resilient, is more than doubling truck tire life. No more impact breaks . . . matchless blowout protection . . . thousands of extra miles, original and retread . . . higher load capacity! Specify Bekaert Steel Wire Cord for lowest cost-per-mile performance. It's available in truck tires made by leading manufacturers.
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liquors obtained from leaching is as follows:

TABLE NO. I
Liquor Analysis
Gm/l

	Leach Liquor	*Reduced Liquor*
Copper	135	0
Cuprous Copper	60	0
Zinc	25	25
Ammonia	135	125
Carbon Dioxide	85	80

Purification

Very small quantities of lead, tin and similar metals are dissolved in leaching. Some small amounts of finely divided leach residues are carried over from the leaching vessel. If the impurities are allowed to remain with the liquor during the reduction step, they can be carried down with the precipitated copper powder and result in an impure product.

* * *

A purification step is used to remove the suspended particles. The purification of the leach liquor is accomplished by agitating the liquor with Celestite (Strontium Sulfate) and then pumping the purified liquor through a filter press. The purified liquor is then pumped through heat exchangers into an agitated pressure vessel (autoclave) at a temperature of approximately 350° F. Hydrogen gas is applied with a sufficient over-pressure to obtain the desired reduction reaction rate.

Reduction and Powder Washing

Hydrogen gas produced from natural gas by a standard gas reform unit is used in the Whitaker Metals plant. The reform unit also has produced hydrogen from commercial propane. The capacity of the unit is 6,000 cubic feet of hydrogen per hour.

* * *

Reduction of metallic copper from solution requires approximately ninety minutes resident time in the autoclave. The slurry of copper powder and lean leach liquor is discharged through heat exchangers to a decanter in which an initial separation of the powder and liquor is made. The liquor is recycled to the leaching tank and a portion is returned to the zinc boil unit.

* * *

The copper powder product from the decanter is centrifuged and washed to remove entrained copper liquor and any other impurities which may adhere to the outer surface of the copper particles.

Drying, Crushing, and Classifying

The metallic copper powder from the centrifuge, containing about 10% moisture, is dried by passing through a standard belt furnace. The atmosphere in the furnace is hydrogen.

* * *

The dried copper powder from the furnace first is crushed in a saw-toothed crusher. The crushed product is classified with over-sized particles from the classifier returning to a hammer mill in a closed circuit with the classifier. Fines from the classifier are collected and charged to a blender. When a blender charge is accumulated, the powder lot is blended to attain uniformity and then packaged.

* * *

All of the powder from one blender batch constitutes a single production lot. Following packaging, a number of random specimens are taken from this lot for chemical and quality control analysis. A typical chemical analysis of copper powder product is shown in Table II.

TABLE NO. II
Copper Powder — Chemical Analysis
Type WM250-60

Copper	99.8
Hydrogen Loss	.1
Lead	.002
Tin	.005
Insolubles	.003
Iron	trace
Carbon	none

* * *

Table III shows the typical physical properties of the powder.

TABLE NO. III
Physical Tests On Copper Powder

	Type WM250-60
Apparent Density, g/cc	2.60
Flow seconds	25.5
Sieve Analysis, %	
+ 80 mesh	0.0
− 80, +100 mesh	trace
−100, +140 mesh	6.0
−140, +200 mesh	10.0
−200, +230 mesh	10.0
−230, +325 mesh	12.0
−325, mesh	62.0

* * *

With the production problems of producing a 99.99% pure copper powder solved, fabrication of solid shapes of copper becomes most interesting. Let me tell you briefly about two of them.

Strip

Whitaker Metals copper powder is poured between a set of compacting rolls applying a force of 120,000 psi. to produce a green compact 0.050 in. thick. The width of the compact or roll faces is 6 in.; thus a continuous green compact 0.050 in. x 6 in. wide is formed.

* * *

By keeping the density in the range of 70 to 80 percent of solid metal, the green compact is porous enough to permit the reducing atmosphere in a sintering furnace to reduce the remaining oxide content of the green compact to a low percentage, substantially below the average reported for conventional electrolytic grade copper strip.

* * *

The green compact is threaded through the sintering furnace using a stainless steel lead strip to support the compact while threading. The furnace temperature is set at 1800° to 1900°F., and as the hot sintered strip leaves the furnace it is reduced in size 20 to 30 percent in a 2-high hot mill. As the strip leaves the hot mill it passes through a protective atmosphere quench chamber where the strip is reduced under atmosphere to room temperature. By careful control of atmosphere protection, a bright clean copper strip is produced, 0.040 in. thick.

* * *

A conventional 4-high mill will roll the 0.040 in. thick strip down to 0.010 inches in four passes. Coils are annealed using a conventional copper annealing cycle.

* * *

Tests have been conducted on standard electrolytic copper 0.010 in. thick for comparison. Standard material shows an average tensile strength of 35,000 psi. and average elongation of 35% to 40% in 2 in. Strip produced from powder shows an average tensile strength in excess of 40,000 psi. with as good an elongation.

Tubing

One of the most interesting items to be fabricated is thin wall copper tubing.

(*Please turn to page* 1456)

Progress Report on the New Model 7 Properzi Equipment for the Continuous Casting and Rolling of Copper, Aluminum and Zinc

by James B. Russell
Chief Metallurgist
Nichols Wire & Aluminum Company
Davenport, Iowa

This paper was prepared for presentation at the Annual Convention of The Wire Association on October 24, 1961, at French Lick, Indiana.

Introduction

Properzi continuous casting and rolling equipment is designed and manufactured by the firm, Continuus — Contruzione Esercizio Laminatoi, Milano, Italy (formerly S.p.A. Continuus). The Properzi process has not only become well known, but is, in fact, the most widely used truly continuous process in the world, the primary application to date being the production of EC aluminum redraw rod.

* * *

The principles of the Properzi process and its historical development, as well, have been previously published (1-13) and need not be repeated here in detail. It will suffice to say that the process consists of two major pieces of equipment: The rotary casting machine and the hot rolling mill in tandem with the casting machine. To these can be added the lubrication system for the rolling mill. To amplify briefly, the ring mold of the casting machine consists, in effect, of a groove, roughly triangular, machined in copper, bounded over an arc of 150° by an endless steel belt which forms a flat (the top) side of the mold. The casting wheel rotates clockwise with molten metal entering the mold through a spout the end of which is immersed in the metal in the mold. The molten metal enters the mold at approximately the 1:30 o'clock position and the solidified casting leaves the mold at approximately the 7-o'clock position, following its natural arc back over the casting wheel and into the rolling mill. Thus the continuously produced casting is immediately and continuously rolled and coiled.

* * *

Each stand of the continuous rolling mill contains three work rolls spaced at 120°, the axles of which ride on roller bearings. One work roll of each stand is vertical, their position alternating from bottom to top starting with the first stand. Suitably placed seals and gaskets serve to keep the water-soluble oil flood lubricant separated from the mineral oil used to lubricate the internal bearings and gears of the roll stands.

* * *

The rolling mill is driven by one motor, AC or DC, the power beng transmitted by V-belt sheaves to the mill's main drive shaft, through the gear boxes of the primary drive system to the spur gear train of the secondary drive system which runs the entire length of the mill (Fig. 10), thereby supplying power to the horizontal drive shaft of each vertical work roll (Fig. 8). These latter shafts constitute the tertiary drive. Power is transmitted from the horizontal shaft of each stand to the two diagonal rolls by means of miter gears on each side of the vertical roll (Fig. 8). The speed of each tertiary drive shaft is based on a predetermined ratio according to the % RIA and speed of the rod at each stand, in accordance with the constancy of volume principle.

All the Properzi continuous casting and rolling equipment, from Model 3 through Model 6, have been based on the abovementioned principles, and each model has proven unique in its ability to receive molten metal at one end of the line and convert it to commercially acceptable redraw rod on a continuous basis, limited only by metal supply, competence of the operating crew and maintenance policy.

* * *

The same principles also apply to the new Model 7 equipment; and the main purpose of this paper is to describe the Model 7 equipment, to compare it with Model 6 and to discuss its potentialities. But first of all some more background information is in order.

* * *

Ilario Properzi has long had his eye on copper. As early as 1954 he had successfully cast and rolled copper on an experimental basis using Model 5 equipment. Figure 1 is a photomacrograph of a section of copper cast at that time. The microstructure was

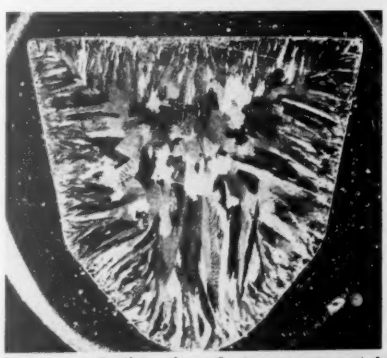

Figure 1 — Section of conductor copper cast in 1954 with Type 5 mold. Magnification: ≈ 2.5.

satisfactory for the intended purpose.

* * *

Experimental and developmental work at the pilot plant level with Model 6 equipment was continued through 1956 and 1957, and proved equally encouraging, so that by early 1958 Mr. Properzi had formulated his plans for the continuous casting and rolling of conductor copper. The new Model 7 equipment is the result of this concerted effort. Cie Vielle-Montagne in D'Angleur, France, has received delivery of Model 7 equipment which willl be put in operation shortly for the production of zinc rod. Southwire Company, Carrollton, Georgia, one of the most progressive Properzi operators in the world, has ordered Model 7 equipment. The rolling mill has been received and can be used to roll copper rod from copper rounds approximately 1½" in diameter taken from the roughing stands of a conventional mill recently installed. Here the starting material will be conventional wire bars. Southwire plans to cast and roll continuously, upon receipt of the casting machine.

* * *

Before the first Model 7 casting machine and rolling mill intended for copper were completed, Mr. Properzi began thinking about what could be done with EC aluminum on this larger equipment. The result is a substantially larger ring mold, to be described, which has a cross-sectional area of 3.383 in.^{2} and a nominal output of 8800/9400 lbs./hr., or about 2½ times the output of the Model 6 machine with the Type 6B mold.

* * *

The Model 7 equipment with its higher output and more rugged construction, has much to offer the large producers of EC aluminum rod, while the Model 6 equipment will continue to be used where requirements are not as large.

* * *

With this background, let us now take a close look at what Mr. Properzi has to offer, via his Model 7 equipment, to the primary fabricators of copper, aluminum and zinc rod.

Model 7 Equipment

Model 6 vs. Model 7:

From the onset it was realized that equipment for casting and rolling conductor copper would have to be considerably more rugged than the Model 6. To this end Mr. Properzi has not only made the Model 7 equipment larger and stronger, but has incorporated a number of changes in basic design and, in addition, has engineered a complete lubricating system for the rolling mill. Some of the main features of the Model 7 equipment are compared, briefly, with the Model 6 in the following table.

Model 7 Casting Machine:

The Model 7 Casting Machine operates on the same principles as the Model 6, the primary difference being its larger and more rugged construction. Several design changes have been incorporated, however, to facilitate a) making of necessary adjustments preparatory to casting, b) ease of operation and c) general maintenance.

* * *

A side elevation and plan view of the casting machine are given in Figures 2 and 2A, respectively. Successful casting is predicated, in part, on precise positioning of the ladle, spout, clamp-down roll and angle of inclination of the belt. Eight independent adjusting mechanisms, all screw actuated, are designed into the casting machine for these purposes and their actions are very similar to those of the Model 6 machine, as previously

GENERAL COMPARISON OF MODEL 6 AND MODEL 7 EQUIPMENT

	Model 6	*Model 7*
Casting Wheel Diam., In.	43	55 to 56
Casting Wheel Horsepower	2	3.7
Mold Area, In.^{2}	1.50 (Type 6) 1.76 (Type 6A) 1.87 (Type 6B)	2.08 (Cu & Zn) 3.383 (EC Al)
Appproximate Output, Lbs./Hrs.	3300 (Type 6) 3600 (Type 6B)	19,800 (Cu) 9,300 (EC Al) 15,800 (Zn)
Casting Machine, No. of adjusting stations	6 manual	8—two motorized
Max. Entry Speed of Casting, FPM	35	49.5
Max. Exit Speed of .375" Rod, FPM	520 (6B Mold)	805 (Cu, Zn) 1,240 (Al)
Weight of Casting Machine, Lbs.	7,150	15,000
Main Housing of Mill	Monolithic iron casting	Same
Rolling Mill, No. of Stands	13	17
Max. Horsepower of Motor	200 (AC or DC)	500 (AC or DC)
No. of Primary Drive Transmissions	2	4
Roll Stand Housing	Built up—bolted construction	Machined from single piece of steel casting
Roll Gap Adjustment	In 2 directions axial and perpendicular to axial direction; screw adjustment.	In 1 direction only perpendicular to axial direction and work; shims used.
Roll Stand Internal Lubrication	Semi Flood Type with relatively "heavy" Lubricant.	Essentially flood type—with "light" oil of SAE-60 or -70 type; amenable to filtering.
Weight of Rolling Mill, Lbs.	29,200	80,000
Speed Ratio of Roll Stands	Uniform — Stands 1 through 3 Uniform — Stands 4 through 13.	Uniform — increases progessively at constant rate of 25%/stand.
Gear and Bearings—Mill's Secondary and Tertiary Drive	Interchangeable Stands 1 thru 3; 4 thru 13.	All Interchangeable
Mill Lubricating System	Pumps and heater supplied.	Complete package units supplied. See Figs. 15 and 16.

* * *

A more detailed description of the Model 7 equipment is presented in the discussions to follow:

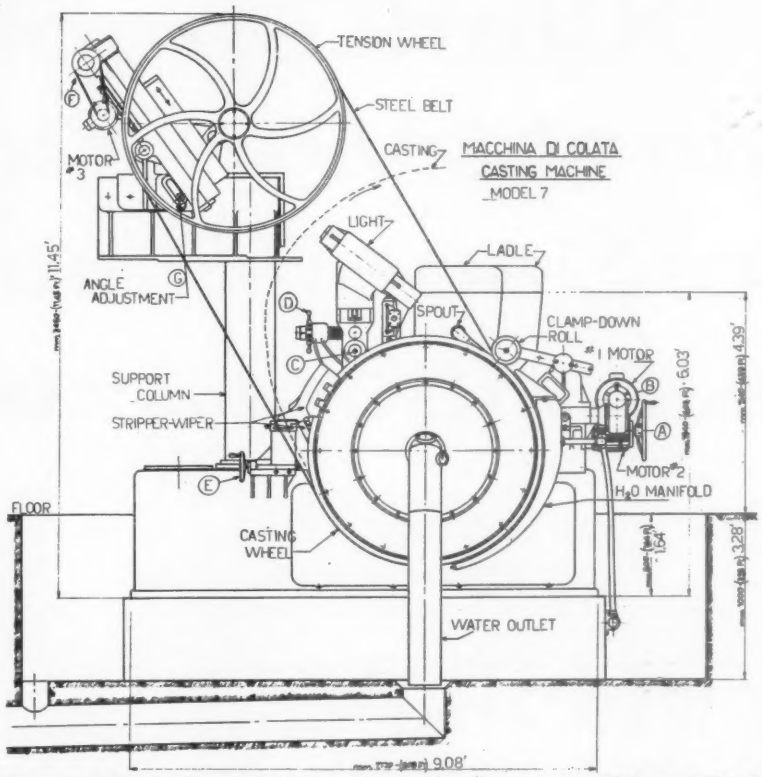

Figure 2 — Side elevation of Model 7 casting machine. Seven control points are indicated by the circled letters A - G. Controls at "B" and "F" are power driven. Machine is preferably mounted in a pit to facilitate operation and disposal of water. * * * * *

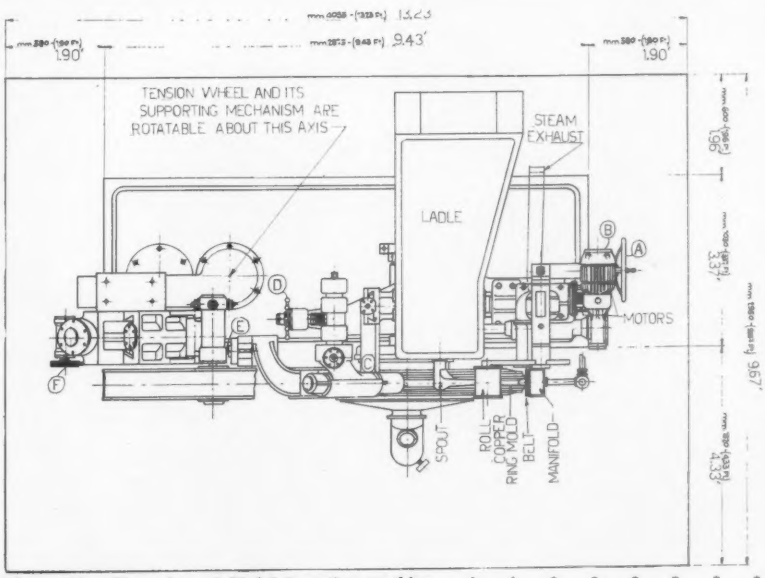

Figure 2A — Plan view of Model 7 casting machine. * * * * * * * *

described[1]. Seven of the eight adjusting stations are identified by letters "A" to "G" in Figure 2. Only four—A, B, C, D—require adjustments at the start of each run, one of which (B) is power driven by motor No. 1. Station "F" is activated only when changing belts, and this, too, is power driven by motor No. 3 which moves the tension wheel up or down via a dove-tail slide assembly.

* * *

The tension wheel and its supporting mechanism are exceptionally strong and the whole assembly has the unique feature of being rotatable about the axis shown in Figure 2A. This innovation expedites the changing of belts and also makes it easier to bring the ladle and spout into operating position.

* * *

Motor No. 2 activates a blower which pulls steam away from the vicinity of the casting wheel, the speed of which is controlled by a 3.7 HP DC motor located within the main housing.

* * *

The features of the new Model 7 casting machine are shown photographically in Figures 3 and 3A, perhaps in a manner more interesting to many than the layout drawings.

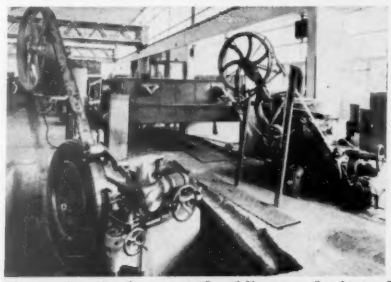

Figure 3 — In foreground, oblique end view of Model 7 casting machine, with ladle removed. A Model 6 machine is to the right. One motorized control is visible at the front of the Model 7 machine. The large hand wheel is for adjusting the belt clamp-down roll, the action of which is entirely independent of the other adjusting mechanisms, an advantage over earlier models. * * * * * * *

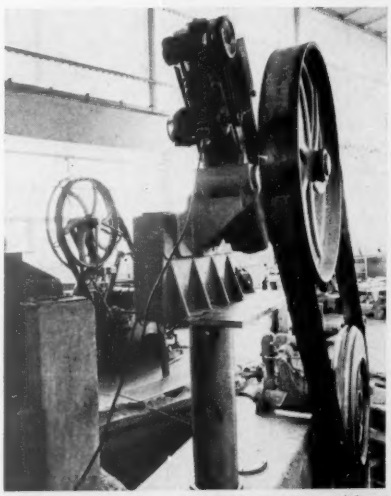

Figure 3A — Model 7 casting machine, without ladle, viewed from opposite end. Note the second control motor and rugged construction of tension wheel supporting mechanism. This latter mechanism is rotatable about the axis of the supporting round column. * * *

* * *

"Clark spools h
Steel & Wire Co. s
of Super-Stitch b
greatly increased th

This spool was designed and produced to exceedingly close tolerances by J. L. Clark Manufacturing Co., of Rockford, Ill. From basic planning through production of the finished product, Clark offers a complete spool service. A wide range of standard sizes is available for insulated wire and cable, and fine wire.

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d the efficiency of our customers' binding and stapling operations."

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According to Mr. Broughton, "The greatly increased core diameter of this new Clark spool reduces the variation of degree of 'arc' between starting and finishing ends, allowing maximum uniformity of 'circle.' Since there are fewer layers of wire on this new large-center spool, we obtain perfect winding at production speeds up to 1000 ft/min . . . and the wire unwinds uniformly on our customers' equipment.

"This improved Clark spool also assures a high degree of flange rigidity, *and has reduced shipping damage to an all-time low.* Furthermore, although we ship these spools on a no deposit/no return basis, we sometimes ask our larger customers to return them to us at our expense. Recently, a Detroit company sent back 685 spools, *all of which we found to be in perfect condition and suitable for re-use on our production lines!* Finally, we are convinced this attractive spool gives our wire a quality image."

Whatever *your* spool requirements may be—insulated wire, cable, solder, enameled wire, or fine wire—you can rely on Clark spools for this superior performance. A Clark representative will be glad to discuss your specific needs with you. Write, wire or phone . . .

1

3

2

4

1) Mounting a Clark spool on a coiling spindle at Chicago Steel & Wire. This spool is unbreakable in normal usage.

2) Here, while one spool is coiling at high speed, another, already filled, is being removed. These Clark spools are lightweight and cost far less than many conventional heavy-duty types.

3) Coiled spools are packed for shipment to Chicago Steel & Wire's customers, which include most of the largest printing and binding firms in the country, as well as box makers, shoe manufacturers, and producers of matches, tags, preformed staples, spiral bindings, and milk cartons.

4) Mr. C. A. Broughton of Chicago Steel & Wire Co. points out excellent coiling characteristics of their Clark spools to plant management men.

The spouts, ladles, mild steel belts, and wiper pads are expendable items but practice has developed satisfactory materials from the standpoints of quality and life of service. Ring molds, with two or three trips to the shop for re-machining, will handle 2 to 3 million lbs. of aluminum.

* * *

Most of the spouts in use today for casting aluminum are made of cast iron. Bare spouts will deliver about 30,000 lbs., but with suitable wash castings their service life can be extended to 70,000 to 90,000 lbs. Some progress is being made in the development of ceramic spout tips and all-ceramic spouts for aluminum. Spouts for copper are being made of glazed Sillimanite or an equivalent refractory.

* * *

The assembly of the casting wheel remains essentially the same as the Model 6, as shown schematically in Figure 4. The

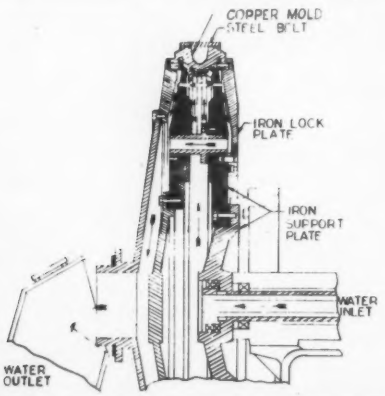

Figure 4 — Properzi casting wheel assembly, showing method of locking copper ring mold into place. Arrows indicate direction of flow of internal cooling water. * * * * *

bottom side of the copper ring mold is cooled internally by flowing water under a positive pressure of 42 psi, minimum, following the path indicated by the arrows. The steel belt is cooled externally by means of water sprays positioned between 2 o'clock and 6 o'clock. The outside spray system has been improved considerably with respect to the Model 6 to give greater cooling efficiency. The minimum water requirement for the Model 7 casting machine is approximately 50 gpm for aluminum and 120 gpm for copper. As a safety factor, at least 80 gpm or 160 gpm, respectively, would be made available at the wheel.

* * *

Cross-sections of the ring molds for casting conductor copper, zinc, and EC aluminum are shown, respectively, in Figures 5A, 5B, and 5C. These sections

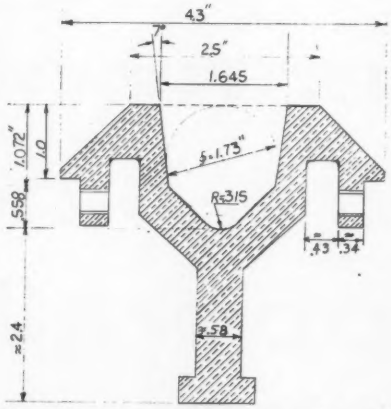

Figure 5A — Cross-section of copper ring mold for casting copper. Area of mold is 2.08 in.² The area of the casting is ≃ 2.005 in.². *

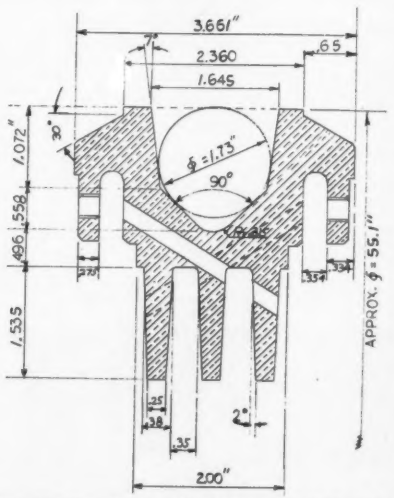

Figure 5B — Cross-section of copper ring mold for casting zinc. Area of mold is 2.08 in.². The area of the casting is ≃ 1.96 in.². * * *

have been selected as optimum from the standpoint of cooling efficiency and strength for casting the metal in question. The cross-sectional area of the molds for copper and zinc is 2.08 in.² while that of the large mold for EC aluminum is 3.383 in.² The crresponding areas for the cast sections are approximately 2.-005 in.² for copper, 1.96 in.² for zinc, and 3.25 in.² for aluminum,

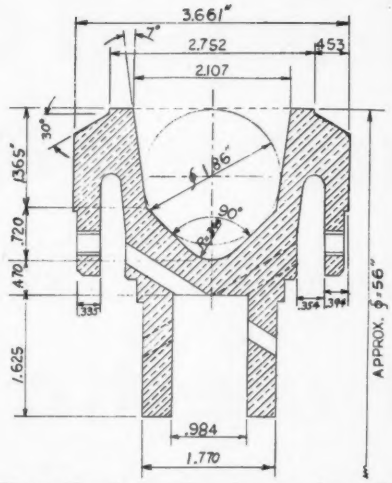

Figure 5C — Cross-section of copper ring mold for casting EC aluminum. Area of mold is 3.383 in.². The area of the casting is ≃ 3.25 in.². * * * * * * * * *

the difference being due to normal solidification shrinkage.

* * *

Over the years, operating experience has led to the development by most Properzi operators of a main control panel, most being similar in principle to the one now used at the Nichols Wire & Aluminum Co., as shown in Figure 6. The

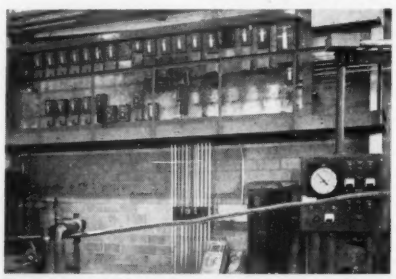

Figure 6 — Commonly used type of movable console containing necessary controls for Properzi casting machine, rolling mill and tiltable holding furnaces. The console has been temporarily pushed away from the casting machine. The cast bar is shown moving from the casting wheel (not shown) at the right to the mill just to the left. * * * * * * *

panel, which has been pushed away from the casting machine for photographic purposes, contains controls for starting and stopping: - lubricant pumps, mill drive motors, casting machine, and hydraulic pumps for two tiltable holding furnaces. Also there are speed jog controls for the casting machine, rolling mill and holding furnace pumps. A pyrometer, which indicates and records the metal temperature in the ladle is also located on

this panel.

* * *

Experience on aluminum has proven the practical convenience of cast steel. The compact roll el, and the same type is recommended for copper.

Model 7 Rolling Mill:

Figure 7 is an oblique front view of the 17-stand Model 7 rolling mill. As previously mentioned the main housing of each roll stand is made of a single piece of having a movable control panassemblies fit into three cylindrical chambers, one horizontal and two at 120° with respect to each other.

* * *

The general construction of a roll stand is more clearly shown by Figure 8, one of many assembly and maintenance drawings supplied with the equip-

* * *

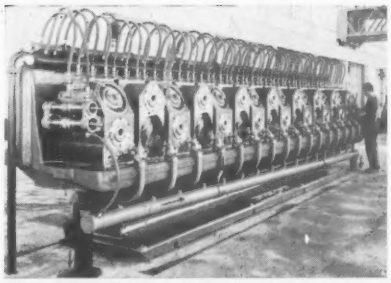

Figure 7 — Oblique front view of 17-stand Properzi rolling mill. Entrance end is in the foreground. The three compact work roll assemblies of each stand fit into cylindrical chambers bored in the housing, which consist of a single piece of cast steel. Three metallic hoses at top of each stand supply the lubricant. Mineral oil for internal lubrication flows under pressure through the center hose and leaves via the curved pipe in front. The water-soluble oil flood lubricant enters through the other 2 hoses, falls to the pan and out through a second collector pipe. Lubricant header pipes run along the top of the mill. * *

ment. Three metallic hoses supply lubricants to each stand. The center one is for mineral oil which floods the internal roller bearings and miter gears, while the two outside ones supply water-soluble oil which serves as a coolant and work-roll lubricant. The roller bearings on which the work rolls ride are designed with a high safety factor (620 HP at 1000 rpm on the main drive shaft) and with the type of mineral oil lubrication described have a rated service life of 5000 hours, minimum, under normal operating conditions.

* * *

Figure 9 shows the rear view of the mill with its secondary drive system completely en-

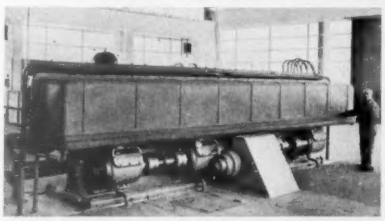

Figure 9 — Backside of Model 7 mill ready for use. Note the four large gear boxes of the primary drive system. * * * * * *

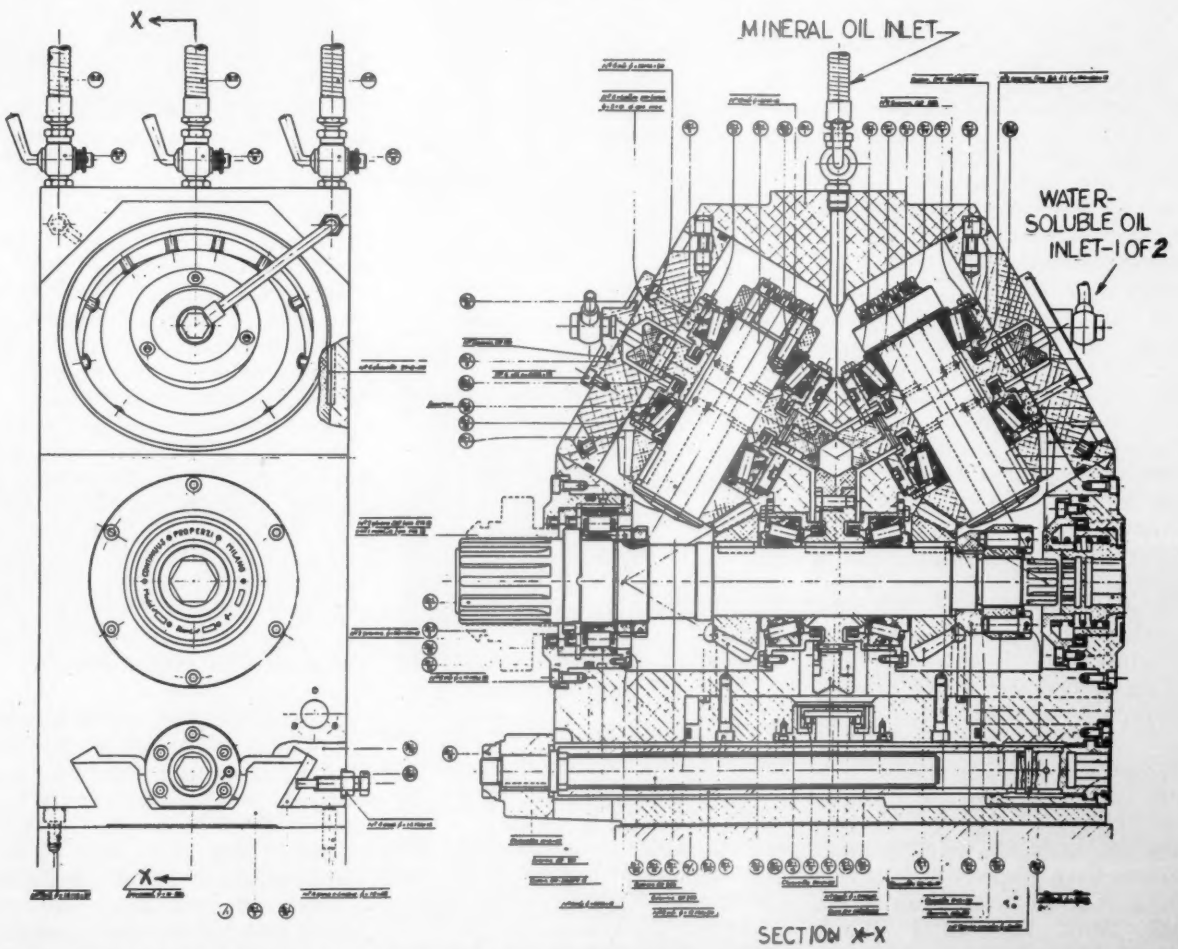

Figure 8 — Typical assembly drawing showing cross section of a Model 7 roll stand. * * * * * * * * * * * * *

closed. Note the four gear boxes of the primary drive system.

* * *

Figure 10 shows the rear view

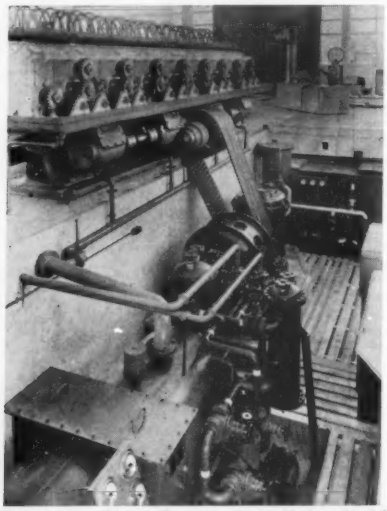

Figure 10 — Exposed rear view of the Model 7 mill showing spur gear train of secondary drive system, the primary drive and the two lubricating systems in the pit. Note interchangeability of gear train. * * * *

of the mill with the spur gear train of the secondary drive completely exposed and the V-belt sheaves of the primary drive are clearly visible. The four gear boxes of the primary drive, along the bottom, tie in with the secondary drive at the 3rd, 7th, 11th, and 15th stands. The installation at the home factory in Italy, where this and the other photographs were taken, shows the two lubricating systems (to be discussed later) and motor installed in a pit. Alternately, this equipment could be mounted at floor level and the lubricating systems even above floor level, if desired, provided additional pump capacity is supplied.

* * *

As with all Properzi mills the main housing of the Model 7 consists of one large monolithic casting of iron, as shown in Figure 11.

* * *

Figures 11A, -B, -C, and -D, show the precision yet rugged construction of part of the primary drive system, starting with the two gear boxes which transmit power to the main drive shaft from the mill's V-belt sheaves (A and B) to the small

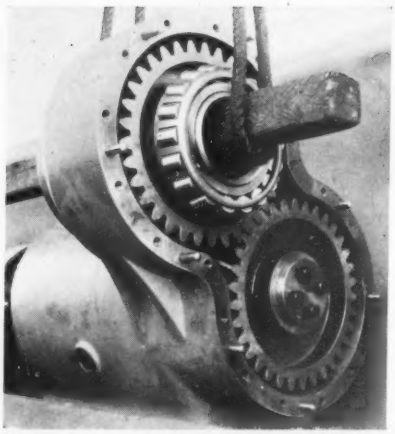

Figure 11-A — Part of the primary drive system. * * * * * * * * *

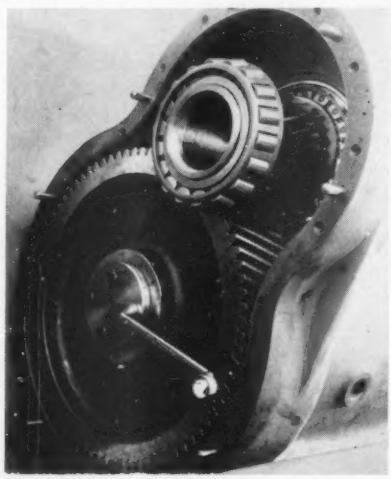

Figure 11-B — Part of the primary drive system. * * * * * * * * *

Figure 11-C — Part of the primary drive system. * * * * * * * * *

spiral bevel gear (D—one of four) at the end of the primary drive which transmits power directly to the secondary drive system. The torque rating of the primary drive is 1328 ft.-lbs. at 700 rpm on the main drive shaft.

* * *

These four photographs were

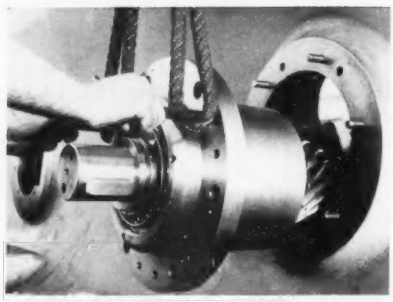

Figure 11-D — Part of the primary drive system. (General caption for Figs. 11-A, B, C, D.) These photographs illustrate the rugged yet precision construction of the primary drive system, starting with the two gear boxes which transmit power to the main drive shaft from the mill's V-bolt sheave (A, B) to the small spiral bevel gear (D—one of four) at the end of the primary drive which transmits power to the secondary drive system. * * *

taken with the main housing tilted on its side, as shown in Figure 12.

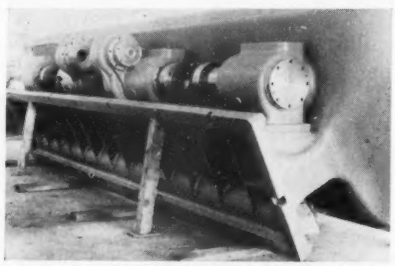

Figure 12 — The main housing of the Model 7 rolling mill consists of one monolithic casting of iron as shown here. * * * * *

The general construction of the Model 7 roll stand has been simplified considerably with respect to the Model 6 stand. Down time due to regular or preventative maintenance should, therefore, be reduced. For example, it takes only about eight minutes to remove a roll assembly from its "socket", and from here perhaps no more than 30 minutes to replace a work roll or a bearing. Seals which separate the mineral oil from the water-soluble are not expected to be a problem. All are of the flat gasket type, made of plastic resistant to elevated temperature.

* * *

Another important design improvement in the Model 7 mill is the guide system between each pair of stands. Roller guides, as shown by Figure 13, are positioned at the entry side of each odd-numbered stand. Tube-type guides with bell entry are used ahead of each even-numbered stand of the Model 7.

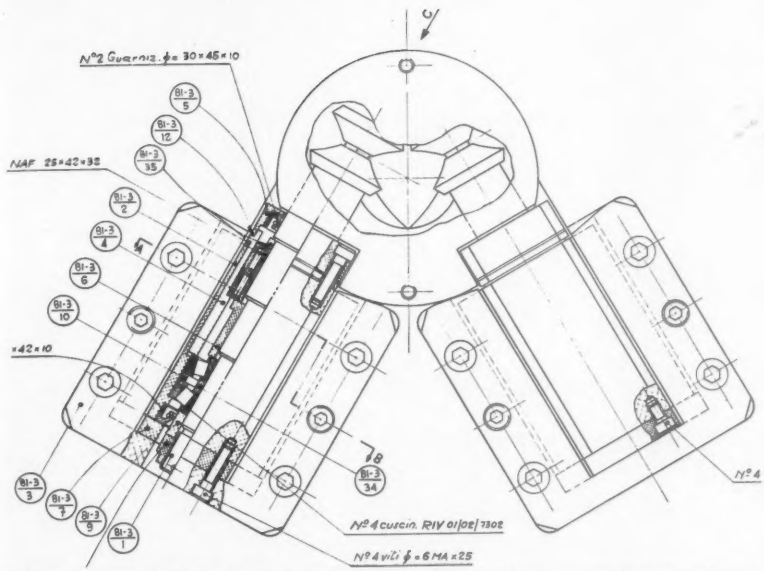

Figure 13 — Assembly drawing of roller guide. Guides of this type precede each odd-numbered roll stand of the Model 7 mill. Tube-type guides with bell entry are used ahead of each even-numbered stand of the Model 7 mill. Part numbers are indicated in the circles.

Model 7 Lubricating System:

Referring to Figure 7, the mineral oil for the internal head lubrication leaves each stand through the curved pipe in front, passing through the large pipe which slopes downward to the right and back to its station for filtering, cooling, and storage. The water-soluble oil is collected in the pan which runs the entire length of the mill (actually the main housing) from whence it flows into the collector pipe below and back to its station for filtering and cooling. This latter collector pipe, which appears black, slopes downward to the left.

* * *

The entire lubricating system at the rear of the mill is shown to scale in Figures 14 and 14A, and this layout drawing also gives pertinent dimensions of the two lubricating systems and rolling mill.

* * *

Figure 15 shows the general construction of the complete mineral oil system, and Figure 16 shows the water-soluble oil system. Realizing that many operators prefer to use copious amounts of water-soluble oil with extra tank capacity to assure adequate evaporative cooling, Mr. Properzi has provided an outlet to a second reservoir which is shown at the top-right of Figure 16.

* * *

The mineral oil system is actually, in a sense, a dual one even though the same oil is used throughout. The scheme is most clearly shown by Figure 14. Oil from the roll stands flows directly from the collector pipe in front of the mill to the reservoir. The gears and bearings of the secondary drive are lubricated by forced flow, through the small pipes which connect to headers along the top and bottom at the rear of the mill, and by splashing of oil collected in the pan. Oil flows from the pan down through the four primary drive gear boxes, and from each of these down to the collector pipe along the bottom at the rear of the mill, and back to the res-

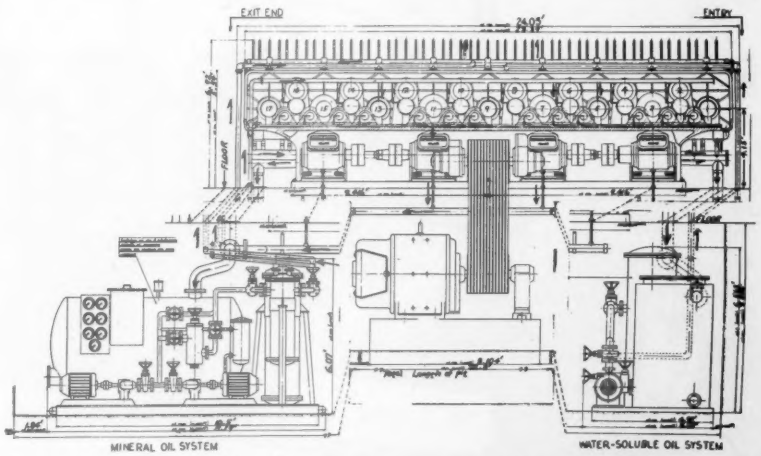

Figure 14 — Layout, to scale, of Model 7 rolling mill (backside) and lubricating system. Lubrication pit is offset downward and to the left, as indicated by the dashed lines. Arrows indicate direction of travel of lubricants. * * * * * * * * *

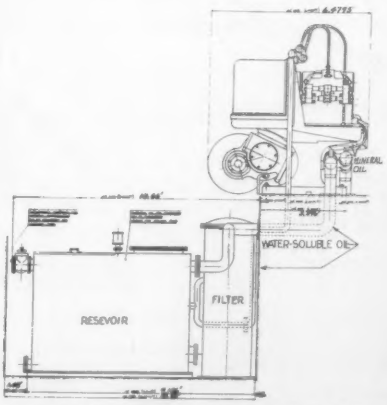

Figure 14 A — Layout, to scale, facing entrance end of Model 7 mill. * * * * *

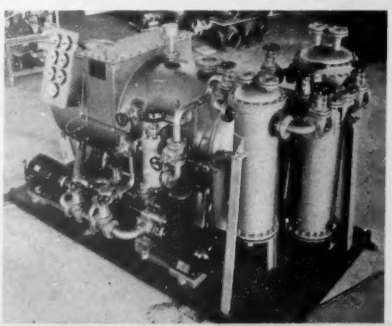

Figure 15 — Close-up of mineral oil system for the Model 7 rolling mill. In addition to the reservoir this system contains two mechanical filters and two direct heat exchangers, water cooled. The system, rated at 40 gpm, handles oil from the primary and secondary drive system as well as from the 17 roll stands. *

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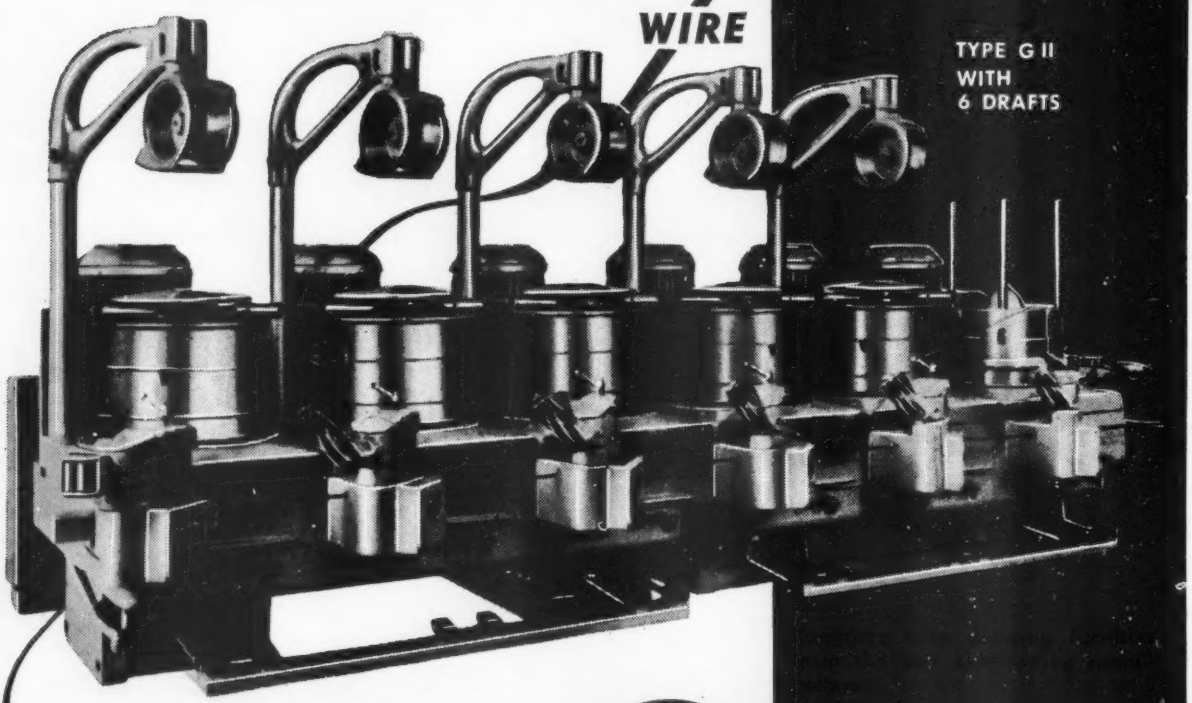

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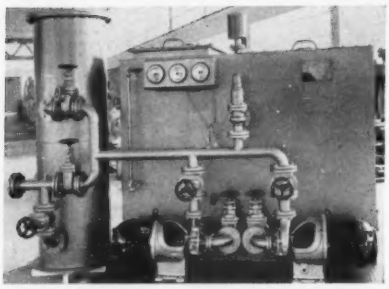

Figure 16 — Close-up of water-soluble oil system for the Model 7 rolling mill. This system, rated at 93 gpm, contains one large mechanical filter in addition to the reservoir. Cooling is by evaporation convection. An outlet (top right) is provided for a second tank. * * *

ervoir to the left. The mineral oil system, as shown in Figure 15, contains the following items:

One Reservoir, 530 gallons.

Two Electropumps, each 8 H.P., 40 gallons/minute—one for use and one for standby.

Two Mechancial Filters, one pack type, one cartridge type. The pack type filter contains horizontal metal discs spaced at 0.0049″ with a total filtering area of 62 in.². The cartridge type contains one vegetal filter capable of filtering out sediment and detritus down to 0.00039″, and is usable for about six months of operation with intermittent cleaning. Cartridge size is 8.25″ OD x 19″ long, with an ID of 2.2″.

Two Direct heat exchangers, water cooled, one for oil from the roll stands and one for oil from the primary and secondary drive systems.

* * *

The water-soluble oil system, as shown on Figure 16, contains the following items:

One Reservoir, 845 gallons for aluminum or 1320 gallons for copper.

Two Electropumps, each 12.5 H. P., 93 gallons/minute—one for use and one for standby.

One Composite mechanical filter, screen and cartridge type. Operating cycle: Fluid passes downward over series of wire screens of decreasing mesh size to catch the "large" particles of foreign matter, then overflows into a second compartment, actually a sump, where sludge deposits, and from here passes into and through a container having 36 fabric cartridges capable of removing sediment and detritus larger than 0.00019″. These cartridges are rated at 1000 operative hours.

* * *

The reservoirs for the mineral oil and water-soluble oil are divided into three compartments. Oil flows into the first compartment which is separated from the second by a weir-type dam over which the oil flows into the second compartment. Heavy sludge, if present, collects at the bottom of the first compartment. The second and third compartments are separated by a series of three screens of decreasing size of openings. These screens are about 8″ apart. Thus, the oil which flows from the third compartment has been cleaned of the coarsest sediment and detritus before passing through the regular aforementioned filters and heat exchangers of the lubricant systems.

* * *

The three screens are readily removed for cleaning and provisions are made for rapid removal of sludge from the reservoirs.

* * *

The normal working temperature range of the rolling mill is 135/150° F. The lubricating systems are designed to prevent the working temperature from exceeding approximately 180° F. When starting up it is not considered necessary to preheat the mill when rolling copper or the large EC aluminum section. Alloys present special problems and the mill, preferably, should be preheated, and this is simply done by installing electrical heating elements in the tanks of the two lubricant systems.

* * *

Being able to use only one light weight oil throughout the mill, amenable to purifying and filtering, constitutes an advantage. Experience to date indicates an oil of the SAE-60 type with properties similar to those listed below for an Italian oil can be used:

Specific Gravity, 60° F.	**0.925(API 21.5)**
Viscosity, SUS, 100° F.	**950-1100 seconds**
Viscosity, SUS, 210° F.	**118* seconds**
Flash Point	**536° F.**
Pour Point	**17.6° F.**
(Molecular Creep)	
Ash (carbon residue)	**1.7%**

No Additives

No fatty acid intention-

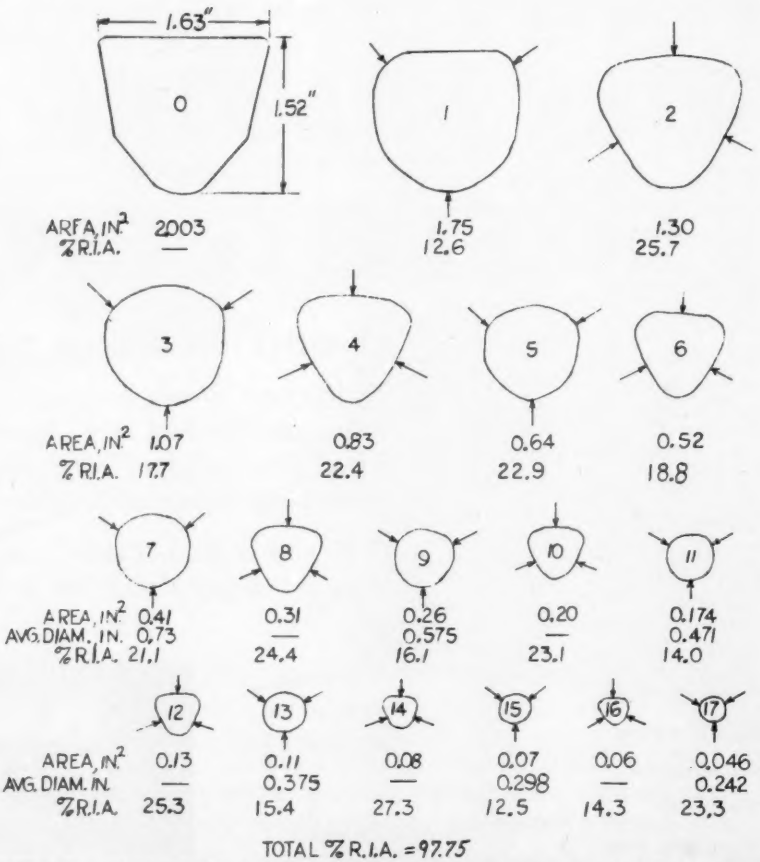

Figure 17 — Standard Reduction Sequence for copper cast in 2.08 in.² mold, showing shape and approximate area for each of 17 stands. Actual tracings of sections rolled on experimental basis. Areas measured by planimeter. * * * * * * * * *

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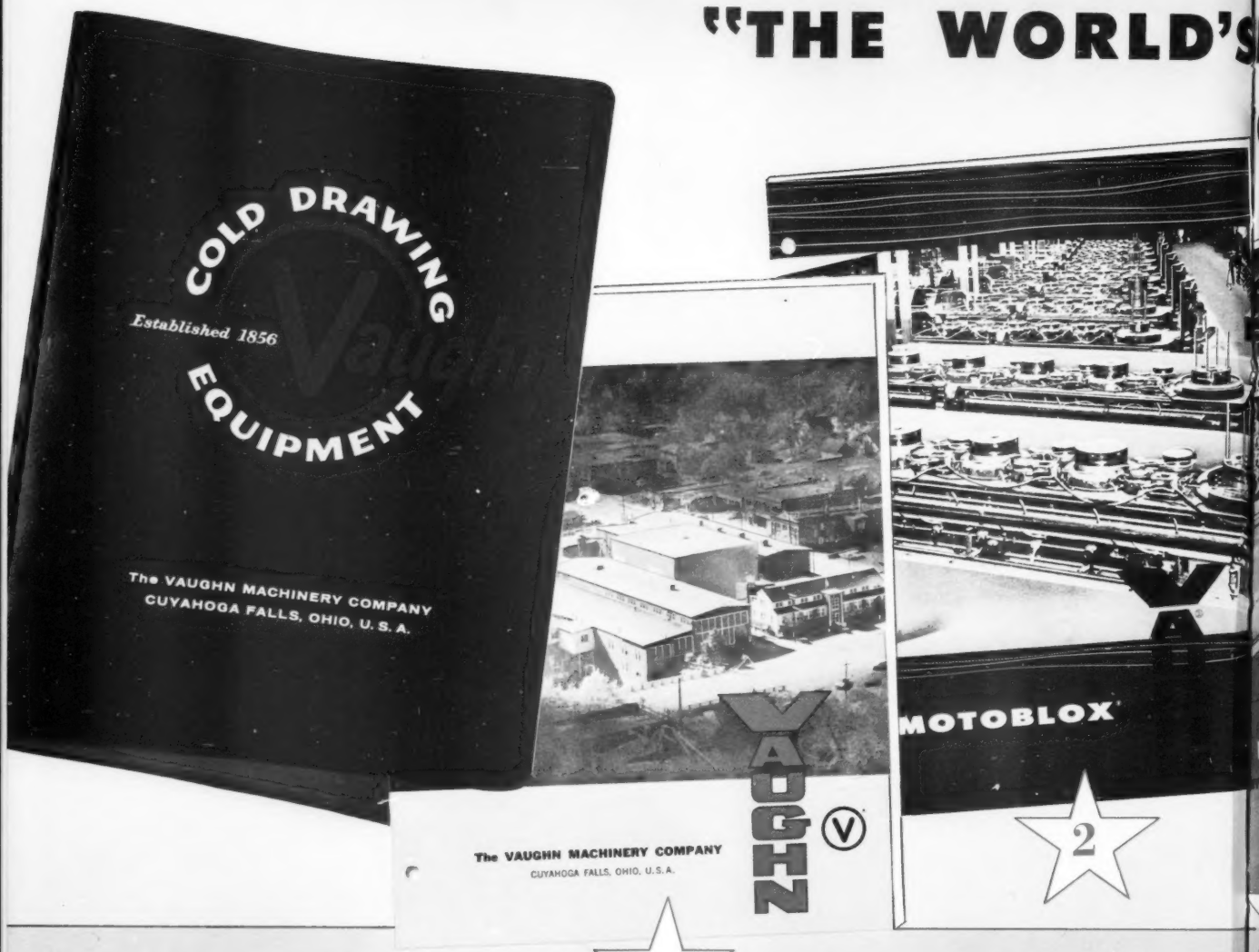

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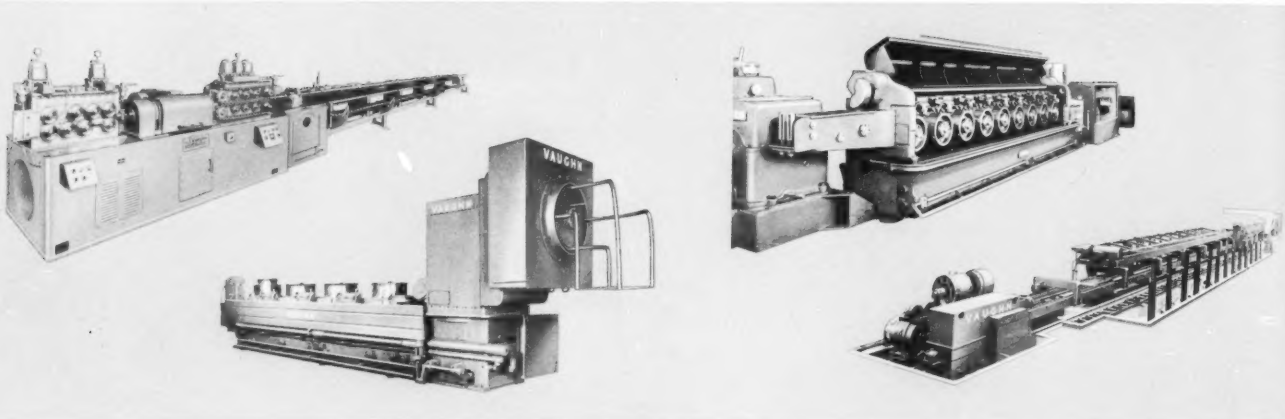

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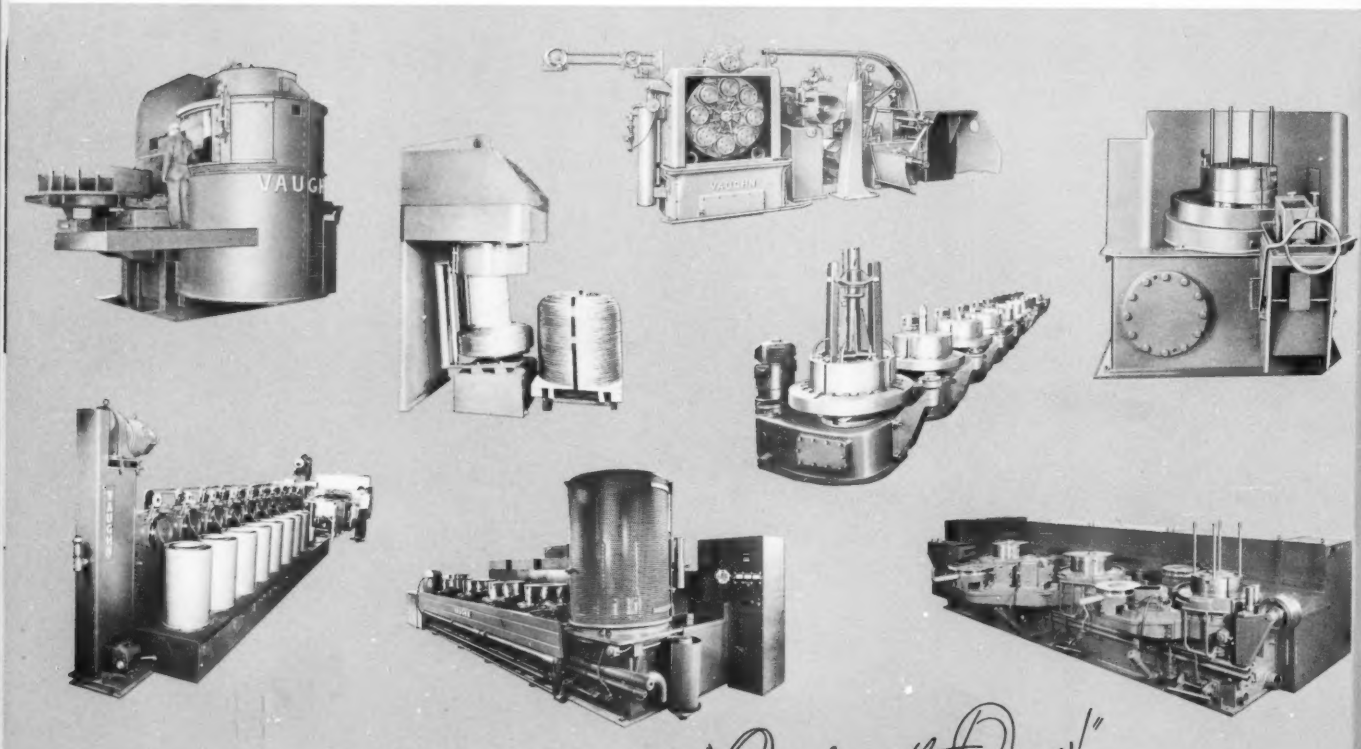

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Model 7 Mill Production Schedules:

With the Model 7 mill rod can be taken off stands 9, 11, 13, 15, and 17. These are the normal round stands, though the circularity of rod off the 7th stand is also reasonably good and even extra large rod off the 3rd and 5th stands could be "bull-blocked" or "drawbenched" to usable rounds.

* * *

A typical reduction sequence for the Model 7 mill is given in Figure 17. The cross-section for each was traced from sections rolled in the mill and their areas as measured with a planimeter. This sequence, which is for casting taken off the smaller (2.08 in.^{2}) mold, for copper or zinc, is approximate only, as the sections were obtained at the factory while in the process of adjusting the roll gaps of a new mill. The main purpose here is to show the shape and approximate cross-sectional area of sections taken from each stand. The round to triangle reduction sequence of the Properzi mill is advantageous from a metallurgical standpoint and gives equally as good or better circularity of rod, than the conventional elliptical — diamond — round sequence. Also, the high strength and rigidity of the Model 7 mill provides good gage control.

* * *

Though roll gap adjustments are infrequently required, plug gages are supplied with the mill to assist the operators in adjusting the gaps. The diameters of these gages also equal very closely the diameters of rod off the round stands. For each stand that gives a section shaped other than round, the diameter represents that of the inscribed circle of best fit with the roll gap properly adjusted. The Standard Reduction Sequence for Copper and EC Aluminum, expressed in terms of plug gage diameters, are listed in Table I.

TABLE I

PLUG GAGE DIAMETERS

Stand No.	Standard Copper Sequence Mold: 2.08 in^2 Casting: 2.005 in^2			Standard EC Aluminum Sequence Mold: 3.383 in^2 Casting: 3.25 in^2	
	Inches	MM		Inches	MM
1	1.502	38.19		1.916	48.71
2	1.143	29.04		1.45	36.85
3	1.182	30.10		1.502	38.19
4	.905	22.98		1.143	29.04
5	.938	23.82		1.182	30.10
6	.718	18.22		.905	22.98
7	.743	18.89	Approx round	.938	23.82
8	.570	14.48		.718	18.22
9*	.592	15.01	round	.743	18.89
10	.454	11.53		.570	14.48
11*	.472	11.95	round	.592	15.01
12	.362	9.19		.454	11.53
13*	.375	9.53	round	.472	11.95
14	.289	7.25		.362	9.19
15*	.300	7.62	round	.375	9.53
16	.2305	5.86		.289	7.35
17*	.239	6.08	round	.300	7.62

*Normal "Rod" stands

The diameters listed in Table I are based on both theoretical and practical considerations, designed to eliminate the maximum amount of slippage. Some slippage can be tolerated, however, and the above diameters are not absolutely fixed. Experience with Model 6 equipment has indicated that the roll gaps can be adjusted to give deviations from the norm in the order of ± .003″ to ± .007″ on diameters off the round stands. Also, changes in the basic reduction schedule can be made at the factory on request, assuming, of course, the change is within reasonable limits. For example, Mr. Properzi has already obliged a potential European customer by working out an alternate reduction sequence for copper to give diameters of .592″, .492″, .391″, .313″, and .25″ off the 9th, 11th, 13th, 15th, and 17th stands, respectively.

* * *

The approximate reduction sequence for the large EC aluminum casting (3.25 in.^{2}) can be readily visualized from Figure 17. In effect, the .300″ diameter rod moves back from the 15th to the 17th stand, and the 1.75 in.^{2} area shown for Stand No. 1 becomes the area of Stand No. 3. The total reduction in area, in either case, is 97.75%.

* * *

Most of the obtainable rod diameters meet current ASTM specifications, as summarized in Table 2.

TABLE 2

PROPERZI ROD DIAMETERS VS. ASTM SPECIFICATIONS

Properzi - Model 7			ASTM*	
Stand No.	Standard Sequence	One Possible Alternate Sequence	Diameters Typical	Range*
		EC Aluminum		
15	.375**	------	.375	.355 - .395
		Copper		
7	.743	(.768)	.750	.730 - .770
9	.592	(.612)	.625	.605 - .645
				.5625
11	.472	.492	.500	.485 - .515
				.4375
13	.375	.391	.375	.360 - .390
15	.300	.313	.3125	.2975 - .3275
17	.239	.25	.250	.240 - .270

*ASTM Specifications B233 and B49.
**Only one diameter is listed for EC aluminum.
All diameters are in inches, those in parentheses being approximate only.

Model 7 Output and Speed Relationships:

Figure 18 gives the output of copper and zinc cast in the 2.08 in.^{2} mold, as a function of casting wheel velocity. The linear speed of the casting is also included. This mold is not intended for EC aluminum and the plot for aluminum is included only for comparison.

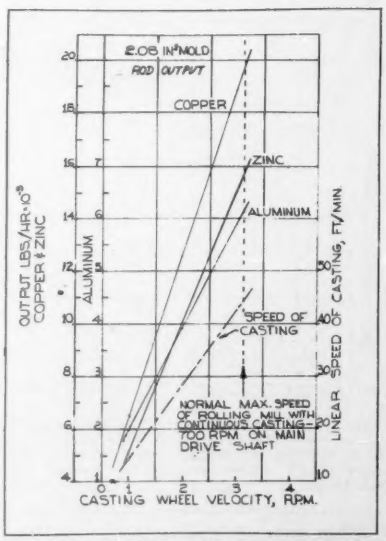


Figure 18 — Model 7 output and linear speed of casting as a function of casting wheel velocity. Applies to copper zinc, and aluminum cast in 2.08 in.^{2} mold. EC aluminum would not normally be cast in this mold and is included for comparison only. * * * * *

Figure 19 shows the linear speed of various sizes of rod as a function of casting wheel velocity, starting with metal cast in the 2.08 in.² mold.

* * *

The same data for EC aluminum cast in the large 3.383 in.² mold are plotted in Figure 20, which, in turn, can be compared with data for the smaller Model 6 mill plotted in Figure 21.

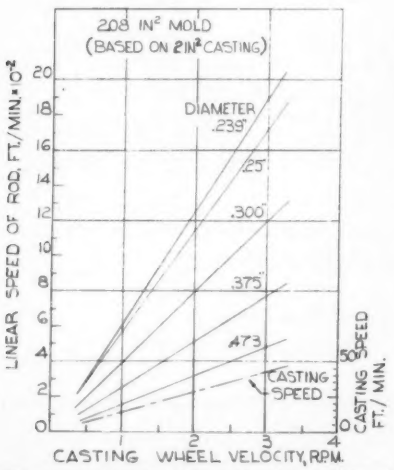


Figure 19 — Linear exit speed of five sizes of rod as a function of casting wheel velocity, starting with metal cast in the 2.08 in.² mold. Casting speed is also shown. * * * *

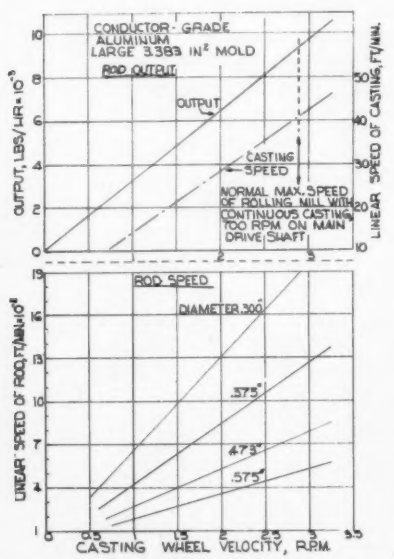


Figure 20 — Model 7 output, linear speed of casting and linear speed of four sizes of rod as a function of casting wheel velocity. Pertains to EC aluminum cast in "Jumbo" 3.383 in.² mold. * * * * * * *

The output and speed relationships for the Model 7 equipment are based on the following calculated data:

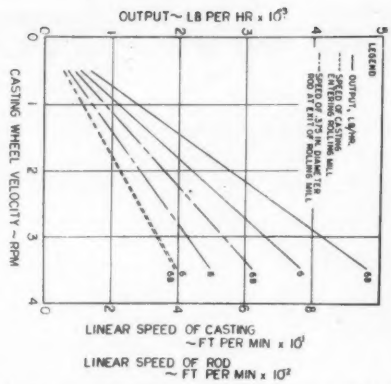

OUTPUT~ LB PER HR x 10³
LEGEND
— OUTPUT, LB/HR.
---- SPEED OF CASTING WHEEL
---- SPEED OF .375 IN. DIAMETER ROD AT EXIT OF ROLLING MILL
CASTING WHEEL VELOCITY ~ RPM
LINEAR SPEED OF CASTING ~FT PER MIN x 10¹
LINEAR SPEED OF ROD ~ FT PER MIN x 10²

Figure 21 — Model 6 output, linear speed of casting and linear speed of 0.375" rod as a function of casting wheel velocity. Pertains to aluminum cast in Type 6 (1.49 in.²) and Type 6B (1.87 in.²) molds. Included for comparison.

	Mold for Conductor Copper and Zinc*	*Large "Jumbo" Mold* for EC Aluminum
Outside Diam., In.	55.12	56.06
Effective Diam., In. (Axis to centroid x 2)	53.82	54.38
Mold Area, In.²	2.08	3.383
Casting Area, In.²	2.005 (Cu) 1.98 (Al) 1.96 (Zn)	3.25 (Al)
Wt. of Casting/Ft., Lbs.**	7.458 (Cu) 2.316 (Al) 5.88 (Zn)	3.803 (Al)
Ft./Revolution	14.09	14.236
Casting Wt./Revolution, Lbs.	105.08 (Cu) 32.63 (Al) 82.95 (Zn)	54.14 (Al)

* Data for Aluminum are included for purposes of comparison and the expectation that special cases may arise where it might prove expedient to cast commercial aluminum in this smaller mold.

** Weights of the cast sections are based on sub-theoretical densities of 0.31 lbs./in.³ for Cu, 0.0975 lbs./in.³ for EC aluminum, and 0.25 lbs./in.³ for Zn. By virtue of the high reduction in area the density of rod off the rolling mill will be at or very close to the theoretical, e. g., 0.32117 for Cu and 0.09765 for EC Aluminum.

Supplemental Applications of Model 7 Equipment — With Notes on Model 6 Equipment —

For Rolling Only:

The Model 7 Properzi mill lends itself very well for the purpose of rolling sections pre-fabricated by conventional means. If pre-fabrication to an acceptable round is accomplished by means of a conventional hot mill, as will be done shortly by the Southwire Company, this round section can be fed hot to the Properzi mill. If the round is produced by extrusion, the extruded round may require an intermediate reheating operation, though a tandem in-line operation is a possibility if a suitable heating arrangement is installed over the runout table of the extrusion press.

* * *

With the mill's roll gaps registered in accordance with the Standard EC Aluminum Reduction Schedule, i.e., for the 3.25 in.² casting, the mill will accept rounds of 1.89/1.92 inches in diameter. This large section would normally be used only for EC aluminum, the commercial aluminums, copper and zinc, or low alloys thereof. By "low" is meant alloys such as AAAC, 3003 or 5005 in the aluminum alloy series, with the further understanding that the increase in resistance to deformation of low copper or low zinc alloys would not be higher than that of the above aluminum alloys, with respect to the resistance to deformation of the parent metal.

* * *

With the mill's roll gaps registered in accordance with the Standard Copper Reduction Schedule, i.e., for the 2 in.² casting, the mill will accept rounds of 1.50/1.53 inches in diameter. In this case, the mill is capable of rolling high (complex) alloys of copper, aluminum and zinc as well as the metal and alloy types listed for the larger section, subject, of course, to hot short limitations of specific alloys.

* * *

From Figure 17 it is quite apparent that the shape of these entering sections does not have to be absolutely round. "Rough" rounds and "rough" round edge hexagonals, within reason, would be accepted by the mill.

The above-mentioned entry diameters are not absolutely fixed. Some leeway is possible provided Mr. Properzi is informed in advance of the customer's exact wishes. For example, the mill will accept rounds or approximate rounds of 1.57/1.60 inches in diameter when the mill is registered for the Alternate Copper Reduction Sequence previously mentioned. This size, incidentally, is the largest presently considered as usable for complex alloys of copper, aluminum, or zinc.

* * *

When casting, the entry speed to the rolling mill is approximately 49.5 FPM, maximum, which corresponds to 700 RPM on the mill's main drive shaft. When rolling pre-fabricated rounds, the maximum allowable speed of the main drive shaft is about 770 RPM, which corresponds to an entry speed of 54.3 FPM.

Solid Sector Cable:

"Solidal" Cable was introduced to the English trade in 1958 by the Aluminum Industries Group. This cable is made of three solid sectors, as shown in Figure 22, and in 3-1/2 or 4 sectors, as shown in Figure 23.

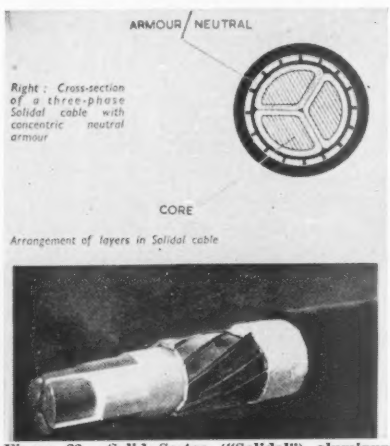

ARMOUR / NEUTRAL
Right: Cross-section of a three-phase Solidal cable with concentric neutral armour
CORE
Arrangement of layers in Solidal cable

Figure 22 — Solid Sector ("Solidal") aluminum cable as developed by Alcan Industries, Ltd. Neutral armour is made of EC aluminum strip. (Reprinted from Metals Industry). * *

Modifications of Solid Sector Cable, particularly with respect to insulation and neutral armour, are still under development. One new construction of British Insulated Callendar Cables, Ltd., is shown in Figure 24.

Figure 23 — 3½- and 4-core solid sector cable. Only the solid sectors and sector insulation are shown. Cables may be used either unarmoured or armoured in various ways according to the conditions of installation. (Courtesy Alcan S. A., Zurich) * * * * * * *

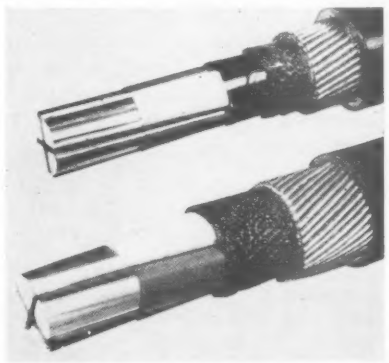


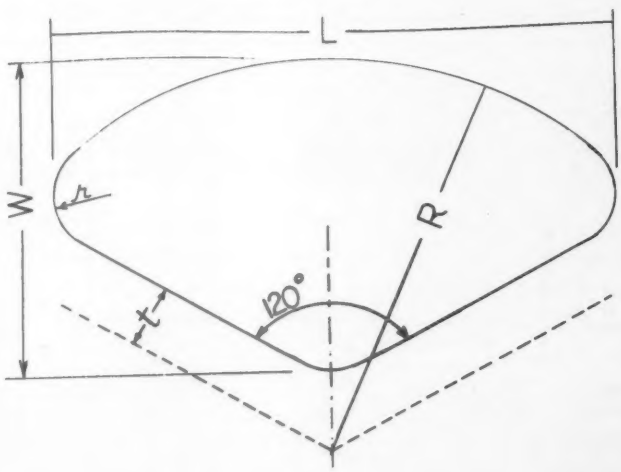
Figure 24 — Four core sector aluminum cable produced experimentally with P. V. C. insulation and steel wire armour. (Courtesy British Insulated Callender Cables Ltd.) * * *

The basic sector sizes, for 3-sector cable, and their respective amperage ratings are given in Figure 25.[14] There are several intermediate sizes in the 100 to 400 amp range which are not listed.

* * *

Solid sector cable is mentioned here as Mr. Properzi has developed special two-high roll stands and guides for the continuous rolling of starting material for both the 3-sector and 4-sector cables, starting with molten metal at the casting machine. The first set of 2-high stands was designed in 1958. At that time the roll pass sequence was such that two, three or four stands were required, depending on sector size. Two such stands are shown in place on a Model 6 mill in Figure 26.

* * *



	CABLE RATING AMPS	CONDUCTOR AREA IN²	R IN.	r IN.	L IN.	W IN.	t IN.
1.	100	0.0413	0.251	0.085	0.343	0.189	0.050
2.	150	0.0829	0.342	0.034	0.489	0.273	0.055
3.	200	0.132	0.421	0.042	0.615	0.346	0.060
4.	250	0.196	0.500	0.050	0.738	0.417	0.065
5.	300	0.275	0.590	0.059	0.876	0.496	0.075
6.	400	0.471	0.770	0.077	1.144	0.648	0.095

NOTE: ATTENTION IS DRAWN TO THE FACT THAT THE RESISTIVITY OF ANNEALED BAR OF ELECTRICAL CONDUCTOR GRADE ALUMINUM MAY BE BELOW THE STANDARD VALUE OF 2.803 MICROHM.- CM. DIMENSIONAL TOLERANCES FOR CONDUCTORS SHOULD BE FIXED WITH RELATION TO THE LIMITS OF CONDUCTIVITY APPROPRIATE TO THE METAL USED, TO OBTAIN THE SPECIFIED RESISTANCES.

Figure 25 — Shape, sizes and amperage ratings of Solidal cable sectors. Each cable consists of three sectors. (Note to Editor: Table can be placed in text, if desired.) * * *

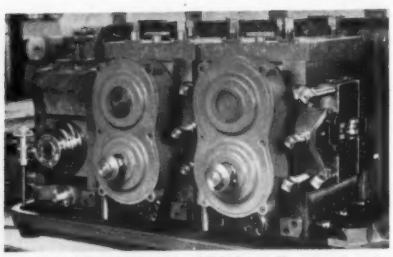


Figure 26 — Properzi 2-high roll stands designed for rolling Solidal Cable Sectors on a Model 6 rolling mill. The same type of 2-high roll stand can be used for rolling sector with a Model 7 mill. * * * * * *

During the interim period the 2-high stand has been redesigned and improved upon. Now only three stands are required to roll the entire range (at least 13) of starting sections. A cross-sectional assembly drawing of one of the newer 2-high roll stands is shown in Figure 27.

* * *

Each different sector size requires a roll change for each of the three stands. This is not a significant problem, however, from a standpoint of downtime, as the stands are so designed that one set of rolls can be changed in 20/25 minutes by experienced personnel, or 60/75 minutes for the three stands.

* * *

Most of the hot rolled sectors require only a sizing pass on a bullblock or drawbench to obtain the exact finish dimensions. By "sizing pass" is meant a reduction in area in the order of 5 to 10%. The remainder of the sector sizes require a greater reduction in area to attain the finish dimensions. This latter procedure, nevertheless, is still relatively attractive from an economic standpoint as compared to the direct extrusion technique currently used to make most of the solid sectors.

* * *

The work rolls of the first 2-high stand, of the series of three, can be designed to accept

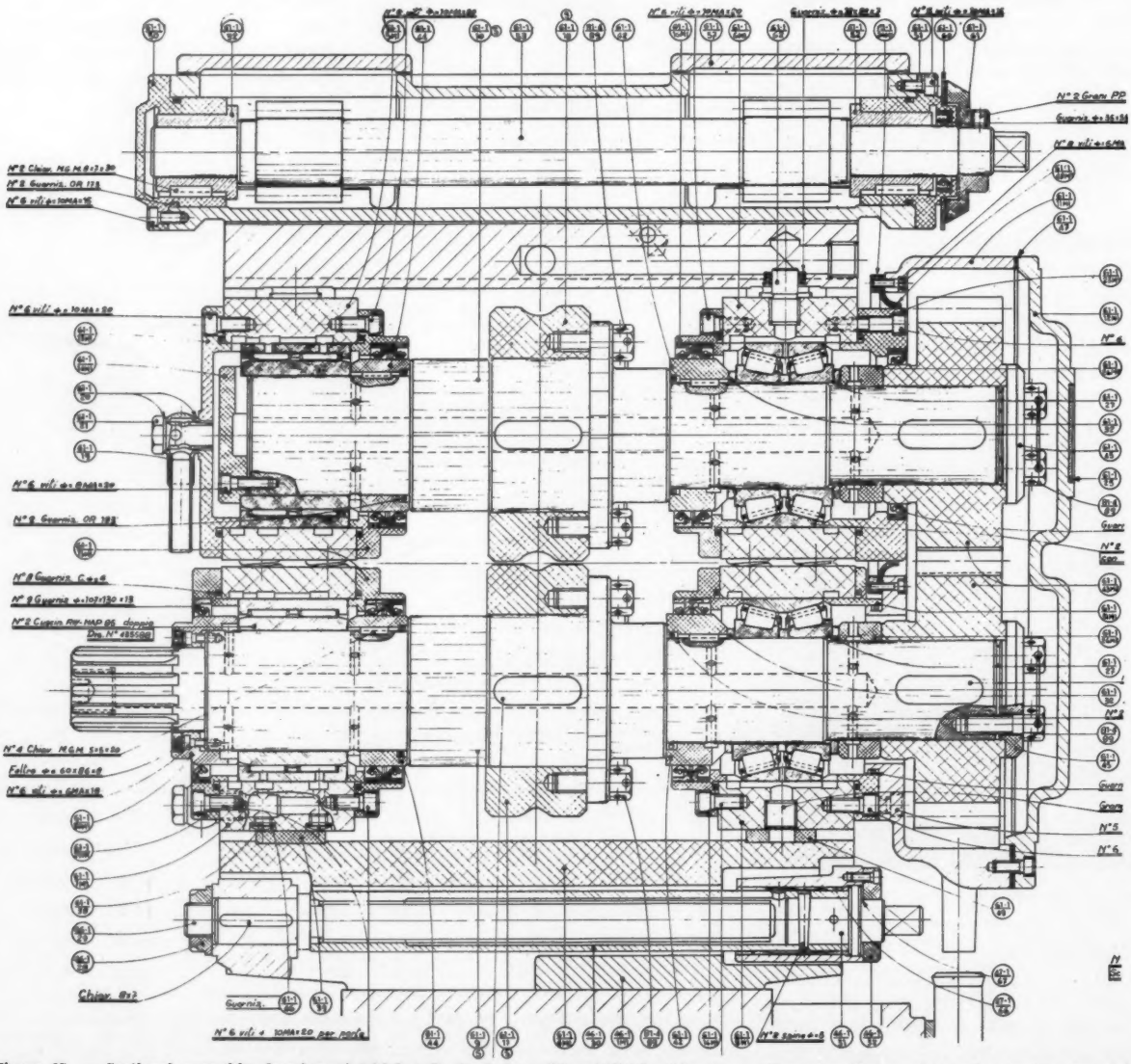


Figure 27. — Sectional assembly drawing of 2-high roll stand for rolling Solidal cable sectors. By using three such stands starting material for all sector sizes, for either the 3-sector or 4-sector cable, can be made by inserting the stands at various positions in the rolling mill. The roll contours can be designed to accept either round or triangular sections in the first stand. This particular stand is designed for the Model 6 mill. Circled numbers refer to various parts. * * * * * * * * * * * * * * * * * *

a "rough" round, a "good" round or a triangular section. Thus, maximum flexibility is afforded with respect to the location in the mill into which the three stands can be inserted.

* * *

Numerous advantages have been claimed and proven for Aluminum Solid Sector Cable construction, some of which are briefly mentioned below:

a. **The shape of the sectors is such that they can be coiled in long lengths from the Properzi mill.**

b. **There are no interstices in the cable construction such as are present in stranded wire cables of equivalent current-carrying capacity.**

c. **This diminishes the overall size of the cable and reduces the amount of insulation required.**

d. **The aluminum sectors are annealed so that maximum conductivity is assured; in England 63% IACS is considered normal with a 62½% guaranty.**

e. **Because of the above factors, the diameter of a fully insulated three-phrase shielded cable of aluminum is slightly less than that of a stranded, compacted sector copper cable of equilvalent current-carrying capacity.**

f. **Even with annealed sectors, the cable has more than ample strength, and the flexibility of the cable is equal or superior to that of the equivalent copper product.**

g. **The concentric neutral layer of aluminum strips also can be produced from Properzi rod, drawn to appropriate size and flattened.**

h. **The corrosion resistance of adequately protected Solid Sector Cable permits direct burial in earth, thereby saving the price of conduit.**

* * *

Additional information on Solid Sector Cables is available. (14-15)

* * *

The total cost of the three two-high stands for Model 6 or Model 7 mills, including guides, tools, gages, and so forth, is reasonable and is more than offset by the flexibility provided to the basic equipment.

Strip Rolling:

Two more unique developments of Mr. Properzi deserve brief mention at this time. Both deal with the continuous production of aluminum strip, starting with molten metal at the rotary casting machine.

* * *

By one method the same type of 2-high stands used to roll solidal sectors can also be used for rolling strip. The number of stands required is predicated on the minimum thickness required. Though strip has not as yet been produced by this method, a rolling schedule along with the general engineering, has been worked out for a potential customer desiring 1"x0.062" strip for making a finned section used in refrigeration equipment and heat exchangers.

* * *

By a second method, relatively wide strip is produced in a rotary "expansion" mill, starting with large rod taken off one of the early stands of the regular rolling mill. The expansion mill, which is very cleverly designed, consists of a roll within a roll, both of which rotate in the same direction. The axis of the inner roll is mounted eccentrically with respect to the outer one so that the two rotating work faces closely approach each other at approximately the 3 o'clock position. Rod is fed into one side of the mill where it passes through the roll gap and emerges as strip from the opposite side, making one complete revolution within the mill.

* * *

This latter forming method is unique in that plastic flow occurs primarily by lateral spreading rather than by elongation in the direction of travel, which occurs in conventional rolling. The main advantage is that the widest possible strip is obtainable with a given starting section. By the first method, i.e., with the 2-high roll stands, the widest strip obtainable is in the order of 1.2" with a Type 6 casting to about 1.5" with a Type 7 casting. With the same starting sections strip widths to at least 3.9" and 5", respectively are obtainable from the expansion mill.

* * *

The strip can be coiled as such for subsequent fabrication or fed by a suitable device directly to a high speed punch press for the production of impact extrusion slugs.

* * *

Development work in connection with the expansion mill has long been completed. In fact, the first production machine is about to be placed in operation by a large Italian company, and in the near future the operating characteristics and performance on a production basis will have been established.

* * *

A more detailed description of these two strip-forming techniques will be published at a later date, when more production information has been accumulated.

Miscellaneous Considerations

Model 7 equipment is the natural outcome of the evolutionary development that has typified the Properzi process. Just where or when this evolutionary process will stop, no one knows — not even Mr. Properzi. This much can be said: In following the process from the Model 3 through the Model 6 the increase in size of the equipment and the casting, coupled with improved engineering, performance and operating techniques, has resulted in a steady improvement in the mechanical and electrical properties of EC aluminum rod. Further improvements will unquestionably follow the use of Model 7 equipment for conductor aluminum.

* * *

The melting, holding and transferring of molten conductor-grade copper to the casting machine has presented problems. Copper has long been continuously cast, and many of these techniques are applicable to the Properzi casting method. The problems have been under intensive investigation by S.p.A. Continuus. Considerable assistance has been found in technical literature on the metallurgical idiosyncrasies of copper, which apply regardless of casting method.

* * *

Conductor alloys of aluminum, such as AAAC, 5005 or 3003 are not nearly as easy to cast as

(*Continued from page* 1440)

Low Stress Elongation (LSE) Testing of Copper Wire

by Matti J. Saarivirta
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This paper was prepared for presentation at the Annual Convention of The Wire Association at French Lick, Indiana, on October 25, 1961.

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Introduction

In the manufacture of fine film-insulated copper wire, it is essential, or at least highly desirable, that the copper soften at the temperature at which the coating is applied. Some coppers meet this requirement, others do not. A method of accurately determining a given copper's softening characteristics is, therefore, of considerable interest. These characteristics are affected by the amount and combination of impurities present. In general, the higher the impurity level the greater the resistance to softening.

* * *

Because the temperature at which insulating film is applied is in the critical softening range for many brands of copper, it has been found necessary to develop an adequately sensitive testing method. Such a method has been developed in the laboratories of **Amco Research & Development, Inc.** It is a simple one requiring a minimum of equipment.

* * *

Other methods are being used with varying degrees of success. Some of these methods are: hardness testing, tensile testing, spring testing and low stress elongation testing (1, 2, 3, 4).

* * *

An attempt was made in this investigation to determine the minimum low stress elongation (LSE) percentage that would indicate the suitability of a given copper for making fine film-insulated wire. Several commercial brands of electrolytic tough pitch copper were selected for this investigation. They had been rated by manufacturers according to their suitability for making fine film-insulated wire. This investigation suggests temperature and time for annealing the test specimens and gives an approximate minimum LSE value.

Procedure and Results

Five different brands of electrolytic tough pitch and one of oxygen free copper were used in this investigation. They were initially hot rolled to 0.32 inch diameter. They were then homogenized at 850° C (1560° F) for 10 minutes, quenched, cold rolled to 0.250 inch, annealed at 600° C (1110° F) for 30 minutes, quenched and finally cold drawn to 0.081 inch wire with 90% reduction in area. The wires were then straightened after which they were cut into 15 inch long specimens. The specimens were annealed in a salt bath at different temperatures between 200 and 275° C (392-527° F) for 20 minutes and quenched in cold water.

* * *

They were then tested by attaching one end of the specimen to the tester in a vertical position and applying a 15,000 psi load (4) slowly to the lower end of the specimen. The constant load of 77.25 pounds (made from an 8 inch diameter copper casting) was maintained for 30 seconds and then slowly released. Percent permanent elongation (LSE) in 10 inches was measured by a 10 inch extensometer. Figure 1 shows the tester used in this investigation. It was a converted drill press. The drill lowering mechanism made it quite easy to apply and release the load in a controlled fashion.

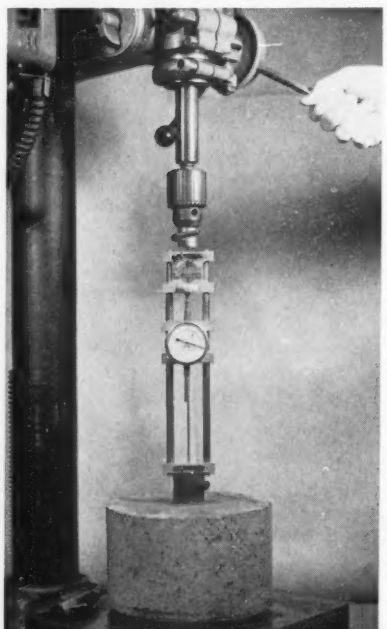

Figure 1 — Apparatus used to determine the Low Stress Elongation (LSE). * * *

Results and Discussion

The consumer's ratings of the suitability of different brands of copper for making fine film-insulated wire are shown below:

Copper No. 1 — very soft (acceptable)

Copper No. 2 — soft (acceptable)

Copper No. 3 — too hard (not acceptable)

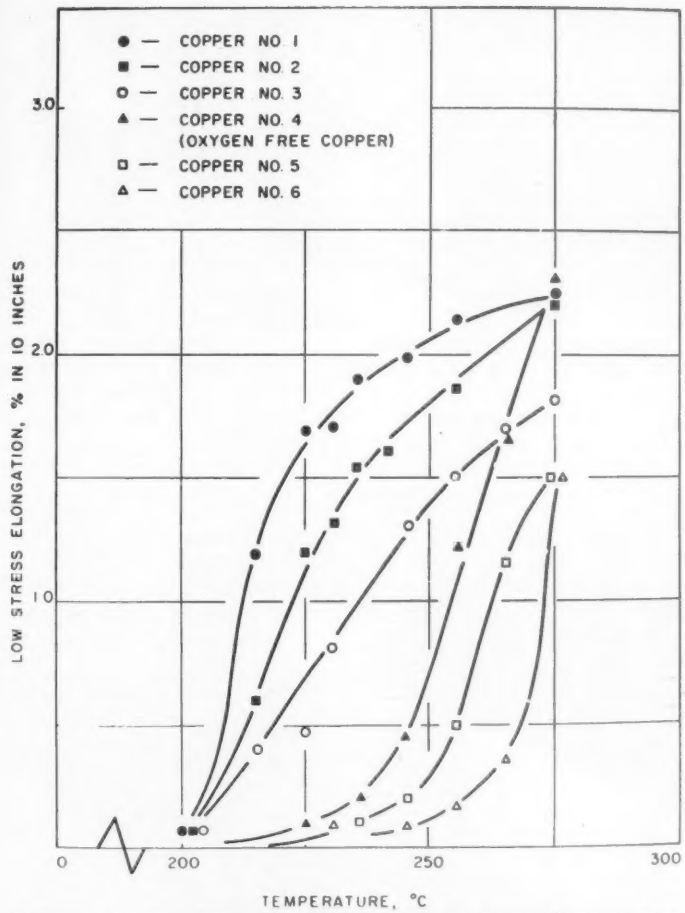

Figure 2 — Low Stress Elongation of different brands of electrolytic tough pitch copper as a function of annealing temperature. Specimens cold drawn 90% to 0.081 inch wire. Annealing Time: 20 minutes.

Copper No. 4* — too hard (not acceptable)

Copper No. 5 — too hard (not acceptable)

Copper No. 6 — too hard (not acceptable)

*** Oxygen free (this brand of copper is usually not used for making film insulated wire, but was included for comparison purposes)**

* * *

The low stress elongation values of these coppers after annealing at different temperatures for 20 minutes are shown in Figure 2. It can be seen that the LSE values increase with increasing annealing temperature, indicating the degree of softening. It is interesting to note also that the different brands of copper have different softening characteristics and that the consumer's suitability ratings for film-insulated wire applications agree with these results. Thus, Copper No. 1 has least resistance to softening, Copper No. 2 next to least, etc.

* * *

The results of this investigation show that the greatest differences in softening between these coppers occur at 200-240° C (392-464° F). At 275° C (527° F) the range of the softness values is significantly smaller than it is when lower annealing temperatures are used. At the lower temperature range, i.e. 200-240° C (392-464° F), the earlier stage of softening is recorded in the coppers that are most suitable for the film-insulated wire applications. After annealing numerous specimens at each temperature and testing, it became evident that consistent results are obtainable with this method. Furthermore, the simplicity of the low stress elongation method makes it less susceptible to human errors. Care must be taken, however, that the diameter of the test wire be measured regularly and the load corrected accordingly. Furthermore, the specimen should not be bent or twisted after annealing. Any deformation work hardens the specimen and causes erroneous results.

* * *

The annealing temperature of 230° C (446° F) was selected as being most suitable for use in routine quality control. At this temperature the most suitable copper has 1.6% LSE, the one rated "soft (acceptable)" has 1.3% and those rated "too hard" have 0.8% and lower LSE. Although it appears that at least 1.0% LSE should be obtained, after annealing at 230° C (446° F) for 20 minutes, longer practice will determine the minimum LSE value more precisely.

References

1. **Otto Nielson, "Recrystallization Problems in Copper Wires", Erzmetall, Vol. IX, 1956, No. 4, pp 151-158 (German).**
2. **S. Carlen, R. Kihlberg and S. Lundquist, "Softness Problems in the Manufacture of Fine Copper Wire for Enamelling", Journal of the Institute of Metals, 1958-59, Vol. 87.**
3. **M. V. Yokelson and M. Balicki, "Progressive Work-Hardening and Reannealing of Five Brands of High-Conductivity Copper", Wire and Wire Products, October 1955, 1179.**
4. **ASTM B279-53T: "Tentative Method of Test for Stiffness of Bare Soft Square and Rectangular Copper Wire for Magnet Wire Fabrication".**

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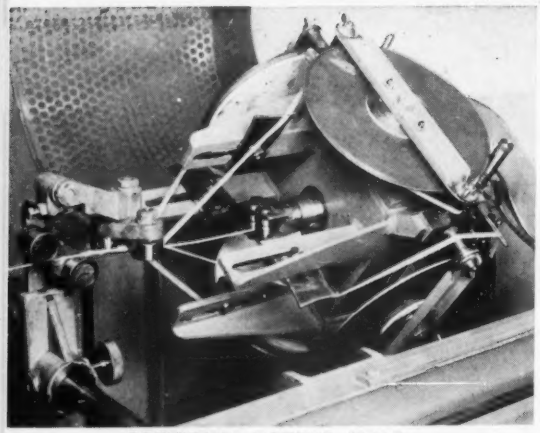

ECCENTRIC TAPING HEAD
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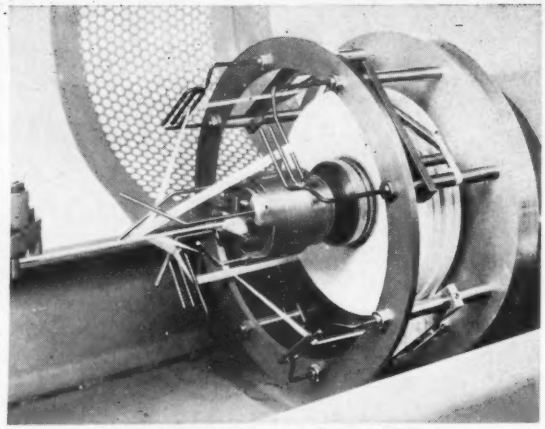
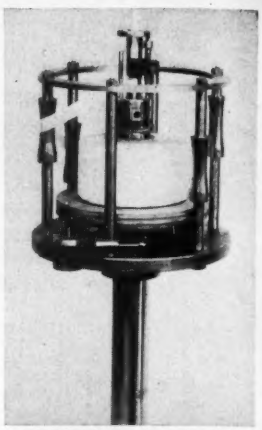


CONCENTRIC TAPING HEAD
NO. 1231 (1, 2, 3 or 4 TAPES)



CONCENTRIC TAPING
HEAD FOR UNIVERSAL
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'APING UNIT NO. 1223. 3 TAP-
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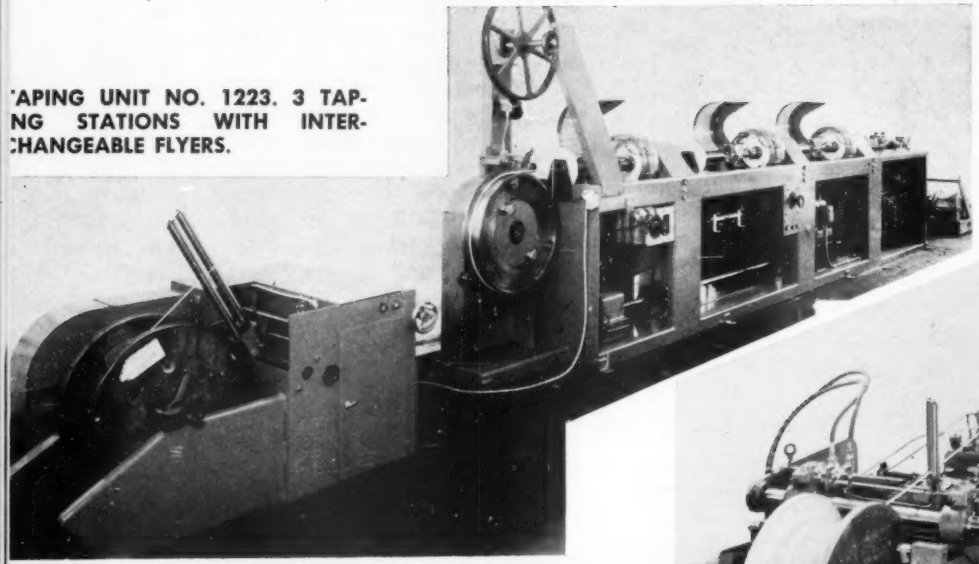
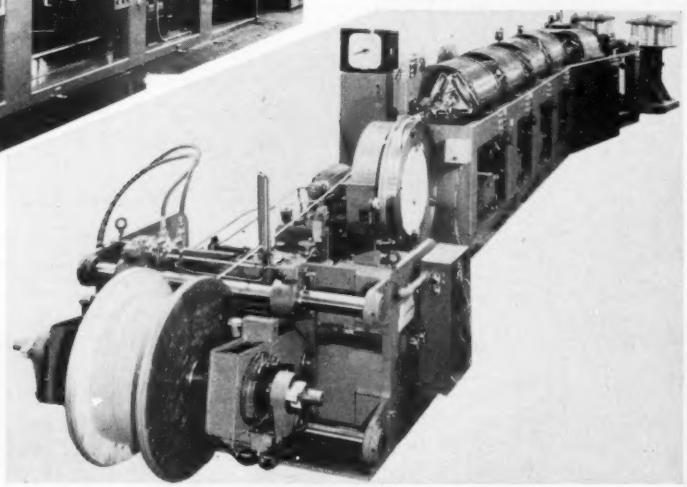
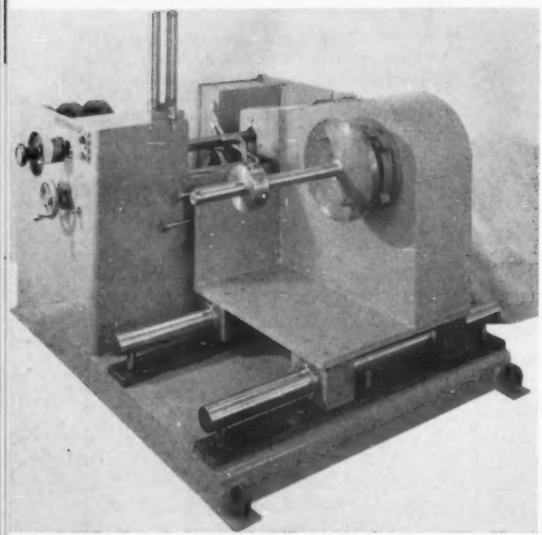


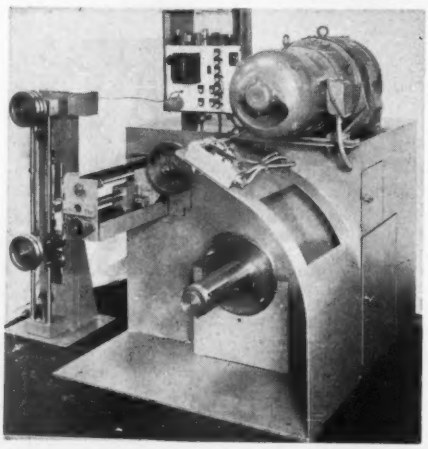
3 WIRES — COMBINING
TAPING MACHINE NO. 1274



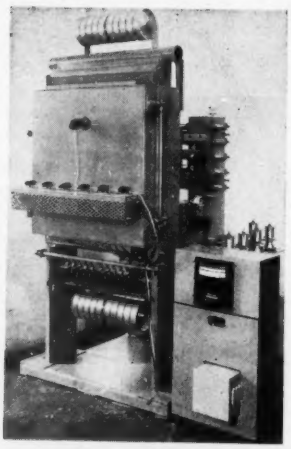


EEL TRAVERSING TAKE-UP NO. 1271
SED BEHIND TAPING MACHINES

HEAVY TAKE-UP NO. 1234, BEHIND
WIRE DRAWING AND TINNING.



M-10 ENAMELING MA-
CHINE NO. 1220 FOR
FINE WIRES, 36 AND
FINER.



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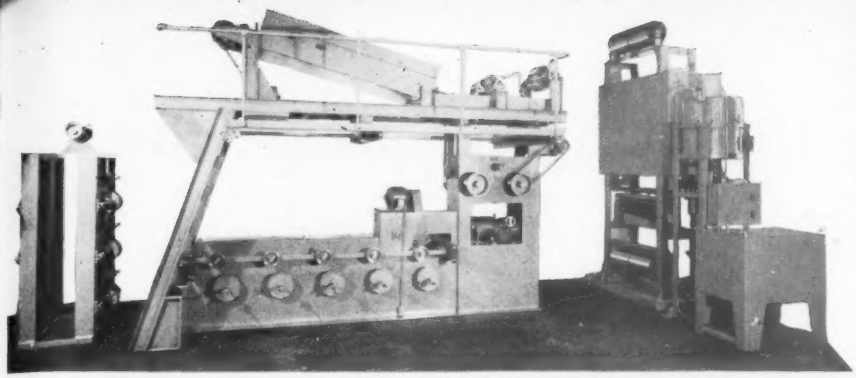
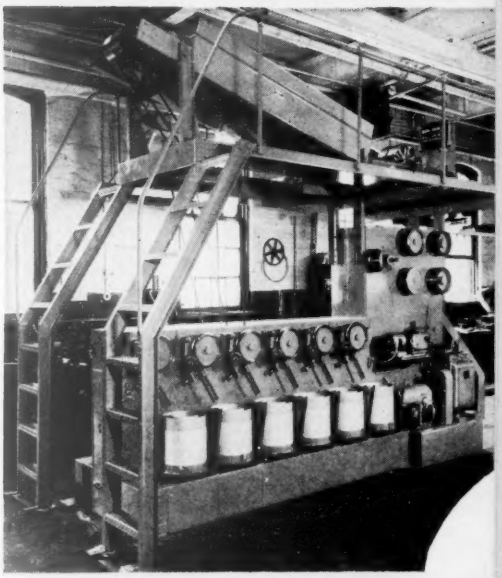
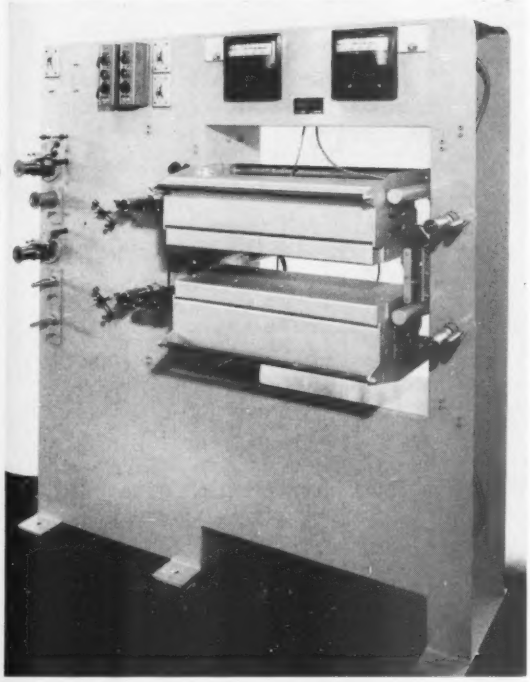


ENAMELING MACHINE AND PRE-ANNEALER NO. 988 FOR REEL TAKE-UP. B&S GAUGE 20 TO 30.



NO. 1237. SAME AS ABOVE FOR BARRELL TAKE-UP, B&S GAUGE 20 TO 30.



HEAVY WIRE TINNING OUTFIT NO. 1010 WITH GAS HEATED TINNING TANK AND AUTOMATIC HEAT CONTROL.

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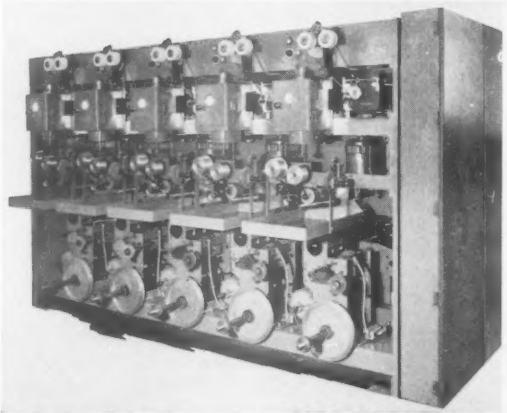
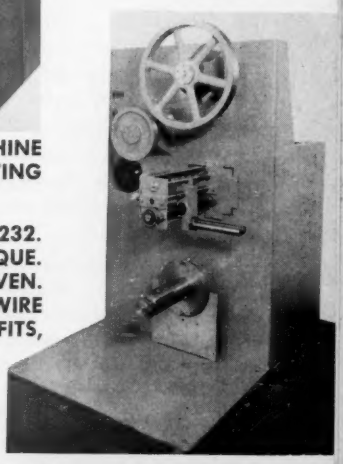
SPEEDS 50-200 F.P.M. — WIRE SIZES DOWN TO .0005 FOR ALLOY WIRES — EASY STRING UP

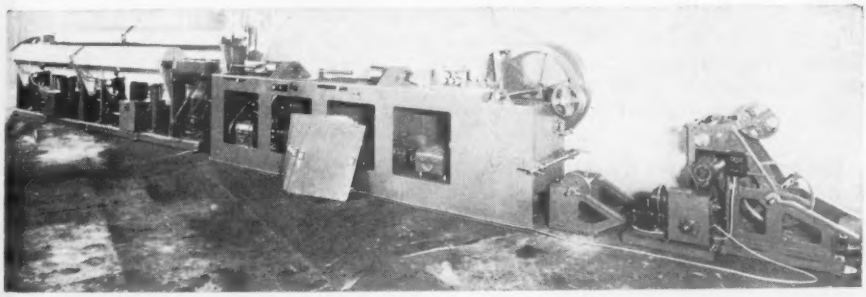
We manufacture a full line of enameling machines from the heaviest flat wires to the smallest diameters.



10 UNIT RESISTANCE WIRE SERVING MACHINE NO. 1295. PRODUCING ELECTRIC HEATING PAD AND BLANKET WIRES.



TAKE UP NO. 1232. REEL-ARBOR TORQUE. MOTOR DRIVEN. FOR USE IN WIRE TINNING OUTFITS, ETC.



GLASS INSULATION WIRE COVERING MACHINE NO. 805, WITH ELECTRIC HEATED VARNISH BAKING OVEN.

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Oil Tempering High Carbon Spring Wire with a Nitrogen Atmosphere Hardening Furnace

by A. I. Cidonio
Industrial Chemist
Pacific Coast Division
The Colorado Fuel & Iron Corporation
South San Francisco, California

This paper was prepared for presentation at the Annual Convention of The Wire Association on October 25, 1961, at French Lick, Indiana.

It is not within the scope of this "paper" to elaborate at length on the functions of the iron-carbon diagrams; the allotropic aspects of iron, the solubility curves and even the structural transformations attributed to the functions of the "Bain" "S" curve; but merely to relate some of the highlights of our experiences with our oil tempering installations at our South San Francisco Wire Mill.

* * *

It is well known that oil tempering high carbon steel wire is nothing "new", as technical papers were published on the subject in Germany and Italy in 1870. These "papers", while not loaded with detailed accuracies, reflected, nevertheless the basic conceptions that govern the present day high carbon spring wire oil tempering practices.

* * *

As we know, the quality resulting from processing under these practices need not be entirely traced to the grade of steel used, total percent of reduction of area, before tempering, grain sizes or structure, but to the fact the "heat" of steel is the initial, discrete entity or lot to be considered.

* * *

By "original discrete entity" we should consider that the initial "heat" of steel is subsequently subdivided into ingots, thus providing sub-lots of the original "heat" of steel. Then when the molten metal has solidified, the product removed from the molds is re-heated and rolled into billets. A multiple number of billets are rolled from each ingot. Consequently, each billet is a sub-lot of a sub-lot. After another re-heating, the steel in billet form is hot rolled into smaller cross-sections commonly known as **rod.**

* * *

About seven years ago, in order to control or evaluate these different physical behaviors of high carbon steel rods, before processing, we decided to make extensive studies of high carbon rods, as received at the South San Francisco Wire Mill from the C. F. & I. Steel Plant at Pueblo, Colorado. After testing every coil of high carbon rods received, prior to drafting, and observing their processing behaviors, the "tenacity" test was developed, and it's still in effect to date. It has continuously been of help to our Production Scheduling Department, as they can route the right "heat" of rods to obtain the best production yield.

* * *

The "tenacity" rod tests, could be generally described as the "naked" eye "fractography" of steel. It prognosticates with definite assurance, the major kinetics of wire drafting by indicating structural cohesiveness and the degree of ductility, as well as "pipes", "seams", "Scabs" etc. These physical indications are more descriptive when the carbon range is from 0.30 to 0.75%.

* * *

The tests are accomplished by securing the specimen samples from the "cleaned" ends of five rod bundles per each heat of rod as received, and fatigue torsioning the same in a reversible torsion machine.

* * *

The distance between the rotating jaws of the torsion machine should be:

$$\frac{\text{Rod Dia. X 100}}{2}$$

The specimens are torsioned a maximum of 10 turns to the right and then reversely for a maximum of 10 turns to the left until failure.

* * *

A numerical value of 25 points is affixed to every 10 turn cycle, or fractional equivalent. These determinations of values are tabulated and re-grouped into three classifications, comprising the most desirable tenacity values such as:

Class "A"	75 points plus
Class "B"	50 points plus
Class "C"	25 points plus

In this manner, Classes "A" and "B" define a certain type of rod expected to render the highest yield upon processing under normal conditioning, to a specific range, and Class "C" type of rod processing physical properties requiring deviation to other end uses or processing under adjusted practices.

* * *

Chart (A) illustrates the principle of functions of the rods tenacity tests.

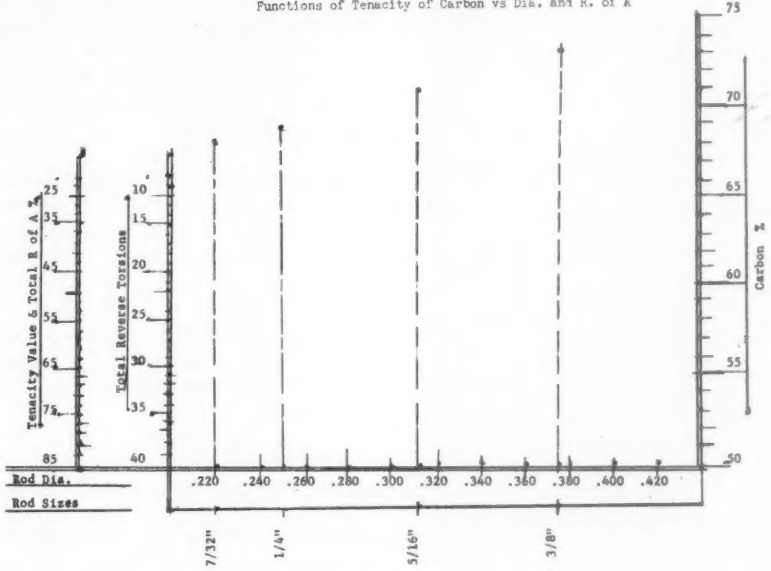
* * *

Chart (B) illustrates the principle of evaluation of the rod tenacity tests.

* * *

Chart (C) illustrates the typical structure of rods revealed by the tenacity tests.

A - NOMOGRAPH OF TENACITY EVALUATIONS
Functions of Tenacity of Carbon vs Dia. and R. of A


Tenacity Value & Total R of A
Total Reverse Torsions
Carbon %
Rod Dia.
Rod Sizes
.220 .240 .260 .280 .300 .320 .340 .360 .380 .400 .420
7/32" 1/4" 5/16" 3/8"

B - TENACITY TESTS REPORT
- H. C. RODS -

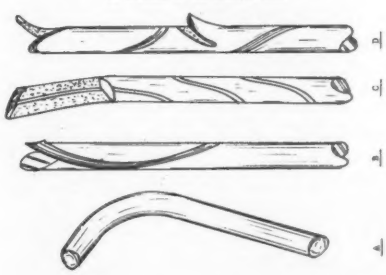
LEGEND -

DATE - 6-23-59
INSPECTOR - 1303
GRADE OF STEEL - KC 6595
ROD SIZE - 7/32
LOT # - 83-13
HEAT # - 01-154
CHEMISTRY -
C - .62 Mn - .94
Ph - .023
S - .024
Si - .20
Cr - .07
Ni - .05
Cu - .14
EXPECTED AVG. VALUES - %
Class "A" - 75
Class "B" - 50
Class "C" - 25
" AVG. CUMULATIVE - 50
AVERAGE DIA. - 227/231
" TENSILE - 132000/134000
" ELONG. 10" - 8.1/10.4

Lab Test #	Id. Tag #	VALUES 10 T L	R	L	R	Total Turns	#	AVG. %	RESULTS OF EVALUATION: CLASS "A"
1	1	10	10	9	–	29	72.5	80.5%	
2	2	10	10	10	10	40	100.0		
3	3	10	10	10	6	36	90.0		
4	4	10	10	10	4	34	85.0		
5	5	10	10	10	2	32	80.0		
6									
7									
8									
9									
10									

TENACITY VALUE - % - 100 80 60 40 20

C - TYPICAL STRUCTURES OF RODS
AS REVEALED BY THE TENACITY TEST



These are, of course, rod test classifications prior to patenting or raw-ripping before oil tempering.

* * *

Due to the fact that a fine pearlitic structure will transform and homogenize at a much faster rate than a coarse pearlitic one, and that cold work will further increase this transformation rate, we have found beneficial to properly prepare the rod microstructure for oil tempering by patenting prior to drawing to size.

* * *

Surface pits or imperfections developed by drawing techniques may create notch-effects that may seriously impair the quality of the products. We test prior to oil tempering, all drawn stock for tensile, and 135° x 3 bend tests to observe possible surface defects.

* * *

We have found that a close control of chemistry is a "must" in high carbon spring oil tempering. In the smaller sizes, a minimum of .63 carbon is essential with a manganese content of .70/.90 to obtain complete hardening. As size increases, so must the chemistry. Heats with manganese content over one percent were apt to be susceptible to bend test failures in our testing procedures, or too brittle to form in some spring applications.

* * *

Both fine and coarse grain steel are adaptable. The coarse grain steel is generally preferable to sizes .312 and larger for regular coiled spring applications because of the increased hardenability which can be obtained. Fine grain steel may be successfully used for all smaller sizes than .312, which are subjected to severe bending and forming.

* * *

The C. F. & I. oil tempering spring wires at the South San Francisco Wire Mill, should be recognized as **new**, because of two pertinent characteristical features: a) the first spring wire oil tempering installation on the West Coast, and, b) an installation with unique processing versatilities.

* * *

The unit "lay-out" stretches from about 250 linear feet, covering an operational area of about 5000 square feet.

* * *

The "lay-out" comprises:

"Pay-off" area
Pre-entering rig
Hardening furnaces
Oil Quenching
Lead draw furnace
Water cooling tower
Surface oiling and wiping tower
"Take-up" block

* * *

The present pay-off area contains 12 self revolving reels, set in a parallel position of 2 x 6. These reels have interchangeable cores to accommodate wire drawn on 30" blocks as well as 16" blocks. The tension and revolving speed of these reels is controlled by a fiber band adjustable brake on the center of the reel. The "pay-off" area is serviced by overhead electric cranes and micro-annealers. The annealer is primarily used to heat a short section of the two ends of each coil of wire, and form a twisted loop into which the lead wire will be connected to initially guide the wire to be oil tempered throughout the entire unit.

The pre-entering rig is attached to the entering door of the hardening furnace. It's about 6 ft. in length and provides for separation of wires and adjustable tension rolls.

* * *

The hardening furnace is about 65 feet in length, 6½ feet in height and 4 feet in width. The furnace is designed to heat a maximum of 4000 pounds per hour of high carbon steel wire, ranging in size from 19 gauge to ⅝" diameter, to a temperature of 1800/1550° F. The furnace length is divided into four zones, each independently controlled, and designed to provide a **minimum** of four seconds soak time, according to wire sizes and ultimate physical restrictions requested by customers' end uses.

* * *

Hand operated doors are provided at each end of the furnace.

* * *

Openings for atmosphere gas and thermocouples are provided at suitable locations.

* * *

The combustion equipment is divided into four separate zones, each independently controlled and fired by means of **Radiant Tube Burners** firing into "W" type radiant tubes. Each zone consists of four radiant tubes, making a total of sixteen gas fired Radiant tubes operating all the time.

* * *

The nitrogen atmosphere is generally provided into the furnace by a gas fired nitrogen generator after its CO_2 content is being adjusted by cooling through a refrigerator and dried through a nitrogen drier, prior to being fed into the furnace combustion equipment.

* * *

The fuel to each zone is controlled by means of motorized ratio valves which proportions gas and air flows as required.

* * *

Air for combustion is provided by means of 12 oz. Combustion Air Blowers complete with integral motor.

* * *

The oil tempering wire leaves the hardening furnace through an exit throat into which there are incorporated a sectionalized top hinged gate to form a radiation shield to minimize atmosphere gas usage.

* * *

As the wire passes through the exit throat of the hardening furnace, it passes through quenching oil directed to the wire by means of weirs. Weir heights are adjustable to assure good flow of quenching oil around the wire.

* * *

The oil tempering quenching unit is about 20 feet long, and provides for about 15 feet extra oil dropping receptacles.

* * *

A total of approximately 600 gallons per minute is circulated over the wire for oil quenching. Of this flow, approximately 400 gpm are re-introduced at the quench entrance, the balance at about the center of the pan to assure uniform positive flow.

* * *

Oil is returned by gravity to the main storage tank for recirculation through a heat exchanger to remove absorbed heat. The heat exchanger requires approximately 300 gpm of 85° cooling when circulating continually, to remove the specific heat absorbed from a maximum of 4000 lbs./hr. to steel wire at 1550°F.

* * *

The temperature control of the oil is effected by means of a by-pass control valve which allows a constant flow of oil through the quench pan, but by-passes the necessary amount through the heat exchanger to maintain the temperature.

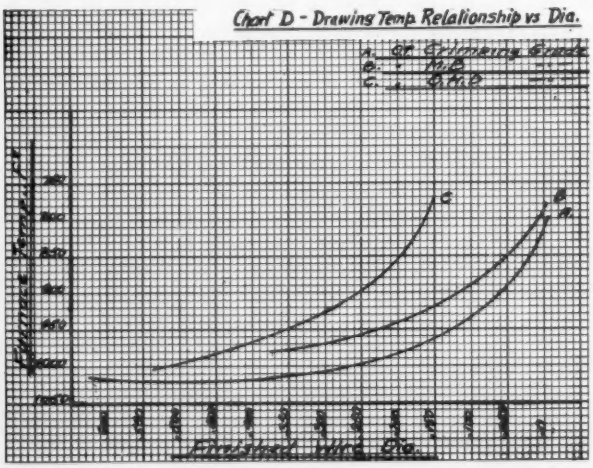
* * *

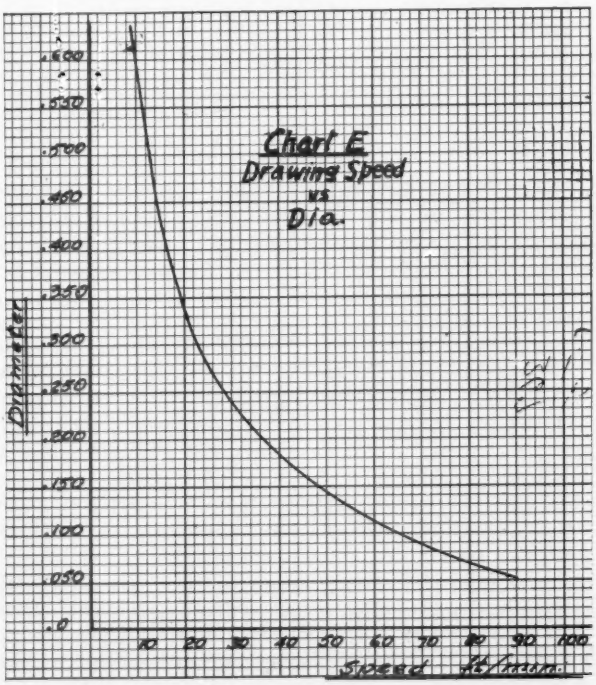
The oil storage tank has a capacity of approximately 1500 gallons and is provided with an electric heated suction type heat exchanger to bring the oil operating temperature between 130° F. to 140° F.

* * *

The drawing furnace is about 25 feet in length, 4½ feet in width

(*Please turn to page* 1458)





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The Properties of Copper-Titanium Alloys

by William B. Steward, Jr., and James J. Powers, Jr.
Research and Development Group
Frankford Arsenal
Philadelphia, Pennsylvania

This paper was prepared for presentation at the Annual Convention of The Wire Association at French Lick, Indiana, on October 24, 1961.
Mr. Steward is a Metallurgist in the Research Division, Research and Development Group, Frankford Arsenal, Philadelphia 37, Pennsylvania.
Mr. Powers is also a metallurgist and is associated with the Engineering Support Division of the same group.

As a preface to this paper, it should be emphasized that the subject matter is not directly concerned with the processing or production of wire products. It is, instead, a rather general summarization of an investigation of a high strength, age hardenable, copper-base alloy system whose properties and processing characteristics should be of interest to the wire industry. The investigation was initiated at Frankford Arsenal[1] during the Korean crisis with the intention of leading to the development of a substitute material for the then critical copper-beryllium alloys. However, expanded development of domestic beryllium resources and cessation of active hostilities resulted in curtailment of the work before it had advanced beyond the laboratory stage. As a result, the observations are in reference to material from small cakes (35 lb. maximum) processed strictly in batch type operations and the data were obtained from specimens of cold rolled strip and bar. One important exception is a sample of several hundred feet of copper-titanium wire that was processed and fabricated into switchboard cord reel springs by commercial facilities.

* * *

Research conducted in this country and in Germany approximately thirty years ago had shown that copper rich alloys of the copper-titanium system were age hardenable and possessed rather attractive strength properties. At that time, however, even moderately pure titanium was a laboratory curiosity and its reactivity with respect to oxygen and nitrogen appeared to present a severe foundry problem. As a result, the alloys were relegated to being considered interesting but impracticable. The vast advances made in the metallurgical industries in the past two decades have removed the stigma of scientific curiosity from titanium and it is now available in commercial quantities and forms. With up-to-date foundry facilities and techniques, melting and casting of copper-titanium alloys should present no unusual difficulties. Sound ingots have been produced by induction melting in graphite crucibles and casting into synthetic sand molds.

* * *

As with most non-ferrous, age hardenable alloy systems, quenching from the temperature of maximum solid solubility places the material in its softest, most ductile form. Subsequent heating at some intermediate temperature produces an increase in strength and a decrease in ductility. Both the level of the as quenched (solution treated) properties and the extent of the changes in properties with thermal aging depend upon the amount of alloying element present. In the copper-titanium system, the solid solubility of titanium in copper is approximately 6 weight percent at 1625°F and decreases to something on the order of 0.5 percent at room temperature. To obtain maximum hardening in a reasonable length of time involves quenching from 1600 to 1625°F and aging at temperatures between 800 and 950°F. Tensile tests of a series of alloys containing various amounts of titanium showed that, as was to be expected, increasing titanium content resulted in increased strength and reduced ductility in both the solution treated and the age hardened conditions. At titanium contents in excess of seven percent, however, the ductility was so low that the alloys were completely unworkable either hot or cold.

* * *

Since the objective of this work was the development of a possible substitute for the copper-beryllium alloys, it was desirable to concentrate on the alloys offering the highest strength in the age hardened condition. In order to be commercially feasible as a wrought material, however, a good degree of cold-workability was also considered necessary. An alloy containing approximately 6 percent titanium appeared to offer the best combination of high strength with acceptable ductility. It offered an age hardened tensile strength on the order of 135,000 psi and yet possessed sufficient workability in the solution treated condition to easily take 50 percent reductions in thickness by cold rolling. A broader study of processing characteristics and aging response was then carried out using material from a series of 35-lb. cakes of a nominal 94 percent copper, 6 percent titanium composition.

* * *

The initial breakdown of the cakes was usually accomplished by open die, impact forging in the range of 1350 to 1600°F. In preparation for forging, the cakes were cropped, scalped and sectioned longitudinally into pieces roughly 2 in. x 4 in. x 8 in. The pieces were then soaked for 3 hours at 1600°F in an elec-

tric furnace and subsequently forged into slabs 3/8 in. thick and 4 inches wide. The actual sequence of reductions in forging was governed primarily by the rate of cooling of the work piece and the speed of the operator. In each instance, forging was continued until the temperature of the slab dropped to approximately 1350°F whereupon it was returned to the furnace for 15 minutes to ensure reheating throughout to 1600°F before continuing.

* * *

Hot working of these cakes disclosed two noteworthy features of the material. One is that the 6 percent titanium alloy appears to be more resistant to deformation, even at 1600°F, than most of the more common copper-base wrought alloys. The other is that the purity of the copper used in preparing the alloys has much more effect on hot workability than does the purity of the titanium additions. The series of 35-lb. cakes was prepared using four different combinations of starting materials; (1) OFHC copper and high purity titanium sponge; (2) OFHC and scrap pieces of commercial purity titanium sheet; (3) electrolytic tough pitch copper and titanium sponge; and (4) tough pitch copper and titanium scrap. The cakes prepared from tough pitch copper were very noticeably more prone to cracking during forging than were the OFHC-base cakes. The form of the titanium additions, however, appeared to have no effect on the hot working characteristics.

* * *

It was realized, of course, that forging is not the usual commercial means of ingot breakdown for material being ultimately processed into sheet or strip. Unfortunately, the maximum roll separation of the available rolling mill coupled with the strength of the copper-titanium alloys made it impracticable to achieve sufficient reduction by hot rolling to ensure complete ingot breakdown and yet allow enough remaining thickness to provide for a reasonable history of cold rolling prior to the desired 0.040 inch finish thickness. A few samples of the cast cakes were hot rolled, however, from approximately 1 inch to 0.100 inch thick for the sole purpose of demonstrating that this material could be broken down directly by hot rolling.

* * *

Upon completion of forging, the 3/8 inch thick slabs were returned to the furnace, soaked twenty minutes at 1600° F and water quenched. After trimming and pickling, the pieces were cold rolled to a finish thickness of 0.040 inch in sequences of 10-15 percent reduction per pass with intermediate solution treatments after each 40-50 percent total reduction. Although the six percent titanium alloy work hardens rapidly (40 percent cold work raises the tensile strength from 85,000 psi to approximately 140,000 psi), it still exhibits good workability. Some samples were cold rolled as much as 75 percent (0.040 to 0.010 inch) with no evidence of edge cracking.

* * *

On the basis of results obtained in this early work, Military Specification MIL-C-46029—"Copper-Titanium Alloy, Plate, Bar, Sheet and Strip" was issued in March, 1959, covering an alloy containing 5.90 to 6.15 percent titanium. Since, however, the mechanical properties cited in the specification were based on aging treatments of 4 hours and were established from tests of 0.040 inch thick strip only, additional work was undertaken to verify the earlier results, to establish data for thicker material and to develop shorter aging

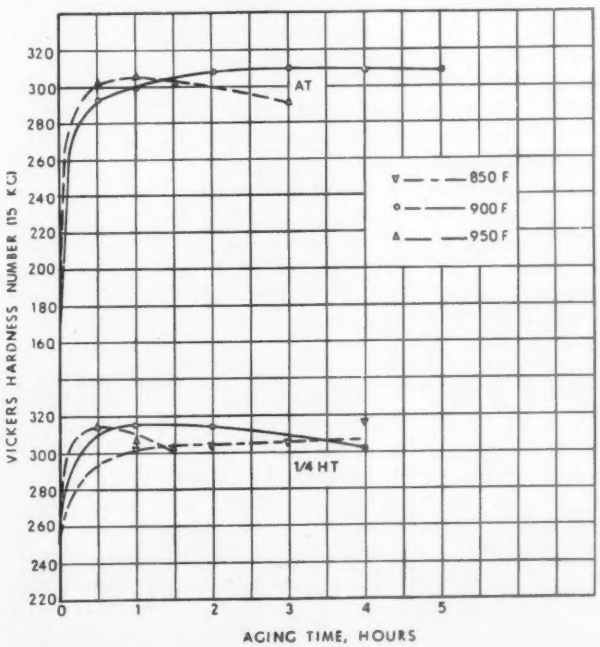

Figure 1. Age Hardening Response of 6% Cu-Ti Alloy in the Solution Treated and 1/4 H Tempers.

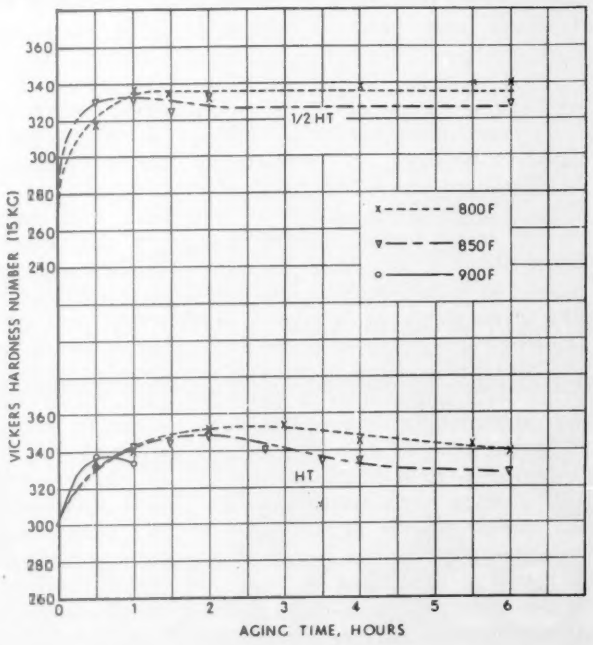

Figure 2. Age Hardening Response of 6% Cu-Ti Alloy in the 1/2 H and H Tempers.

cycles[2].

* * *

The castings produced for this work were sectioned into 1 1/2 inch thick slabs and broken down directly by hot rolling at 1600°F. Slabs intended for finishing to 0.040 inch thick strip were hot rolled to 1/2 inch thickness with the aid of two intermediate reheats. Those to be finished into 0.375 inch thick bar were hot rolled to 0.915 inch thickness without the necessity of reheating. After hot rolling, the slabs were again solution heat treated, water quenched, trimmed and pickled. Cold rolling was then carried out in essentially the same fashion as described previously with the exception that the thicker pieces required more frequent softening to prevent excessive curling.

* * *

Samples of the strip in the solution treated, quarter hard, half hard and hard tempers were aged at temperatures from 800 to 950°F for various times and used as a basis for establishing desirable aging treatments. Hardness data obtained from these pieces are plotted in Figures 1 and 2. Figure 1 shows the hardness vs aging time at various temperatures for material aged from the solution treated condition and from a quarter hard temper. For the solution treated material, it can be seen that while aging at 900°F produced maximum hardening after about 4 hours, a comparable peak in hardness is obtained after 1 hour of aging at 950°F. Although the shorter aging time would seem to be more desirable from a commercial viewpoint, the actual level of hardness obtained from aging at 900°F is slightly higher than from 950°F. Other data, not shown in the figure, indicate that somewhat higher properties yet can be attained by aging 6 to 8 hours at 850°F. The quarter hard material exhibits similar trends at aging temperatures 50°F lower. That is, 4 hours at 850°F or 1 hour at 900°F result in maximum hardening. Comparable data for material aged from the half hard and full hard conditions are shown in Figure 2. Here again the presence of additional cold work induces more rapid aging response with the result that 1 to 2 hours at 850°F or 3 to 4 hours at 800°F will produce maximum hardening.

Table I - Nominal tensile properties of 94% Copper - 6% Titanium alloy

Temper	Heat treatment °F	Time	Tensile strength, kips	Yield strength (0.2% offset) kips	Elongation % in 2 inches
		0.040 inch Strip			
A	1600	10 min.	83	53	32
1/4H	None		117	104	5
1/2H	None		121	114	3
H	None		144	133	3
AT	900	4 hrs.	132	115	15
	950	1 hr.	129	112	14
1/4HT	850	4 hrs.	144	117	13
	900	1 hr.	138	113	13
1/2HT	800	4 hrs.	149	132	7
	850	1 hr.	151	130	8
HT	800	4 hrs.	161	143	4
	850	1 hr.	159	143	4
		0.375 inch Bar			
A	1600	10 min.	107	75	20
1/4H	None		126	106	11
1/2H	None		140	125	7
H	None		165	138	4
AT	900	4 hrs.	133	115	15
1/4HT	850	4 hrs.	139	120	13
1/2HT	800	4 hrs.	150	128	11
HT	800	4 hrs.	165	145	3

* * *

These data, of course, refer only to the influence of thermal aging on hardness itself. To determine the corresponding tensile properties, a series of tests were conducted using tensile specimens that had been subjected to various aging cycles. Results showed that while, in general, the tensile properties follow the trends anticipated from hardness results, the yield strength and elongation values are more sensitive to overaging than either the hardness or the ultimate strength. This is particularly evidenced by a consistently lower maximum yield strength resulting from the higher aging temperatures. Table I is a summarization of the tensile properties that can be obtained from the 94 percent copper, 6 percent titanium alloy in various conditions. A comparison with other common high strength copper-base alloys, illustrated in Figure 3, shows that the mechanical properties of the copper-titanium alloy lie between those of the 1 and 2 percent copper-beryllium alloys. Although other data obtained from the earlier study indicate that the electrical conductivity of the copper-titanium is significantly lower than that of copper-beryllium, its elastic modulus and endurance limit compare favorably with copper-beryllium. In addition, the higher aging temperature associated with the copper-titanium alloy promises somewhat improved elevated temperature stability.

* * *

As mentioned in the introductory paragraph, the only portion of this work that approached commercial handling was the processing and fabrication of several hundred feet of copper-titanium wire into switchboard cord reel springs. These springs are normally made from copper-beryllium alloy and are, in essence, a 90-inch length of 0.010 inch thick flat wire coiled on itself tightly enough to fit within a 1 7/16 inch diameter retaining clip. Among the property requirements imposed on the wire are a 150,000 psi ultimate tensile strength, a minimum bend

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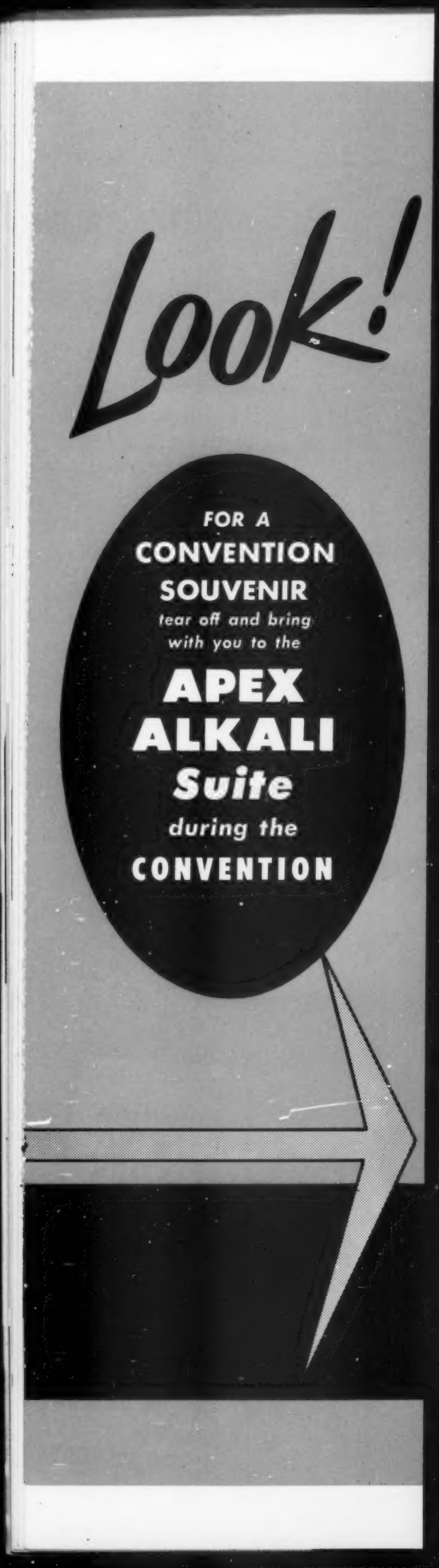
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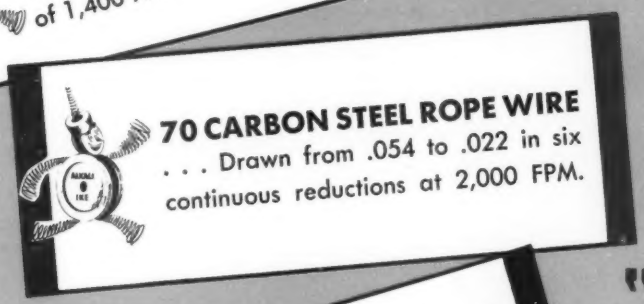

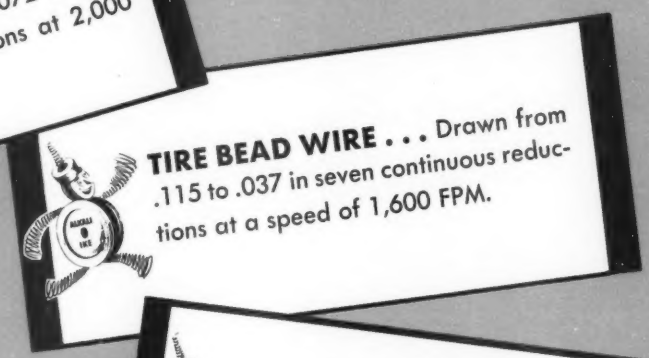

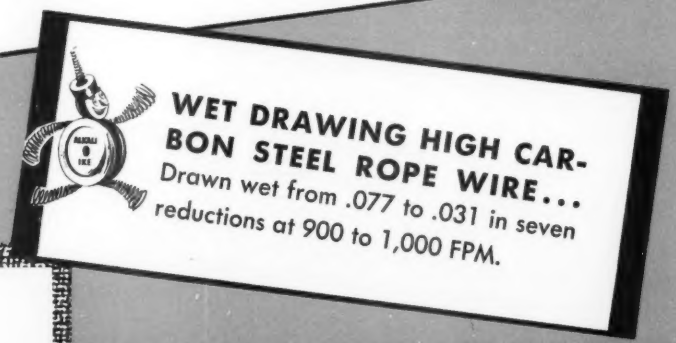

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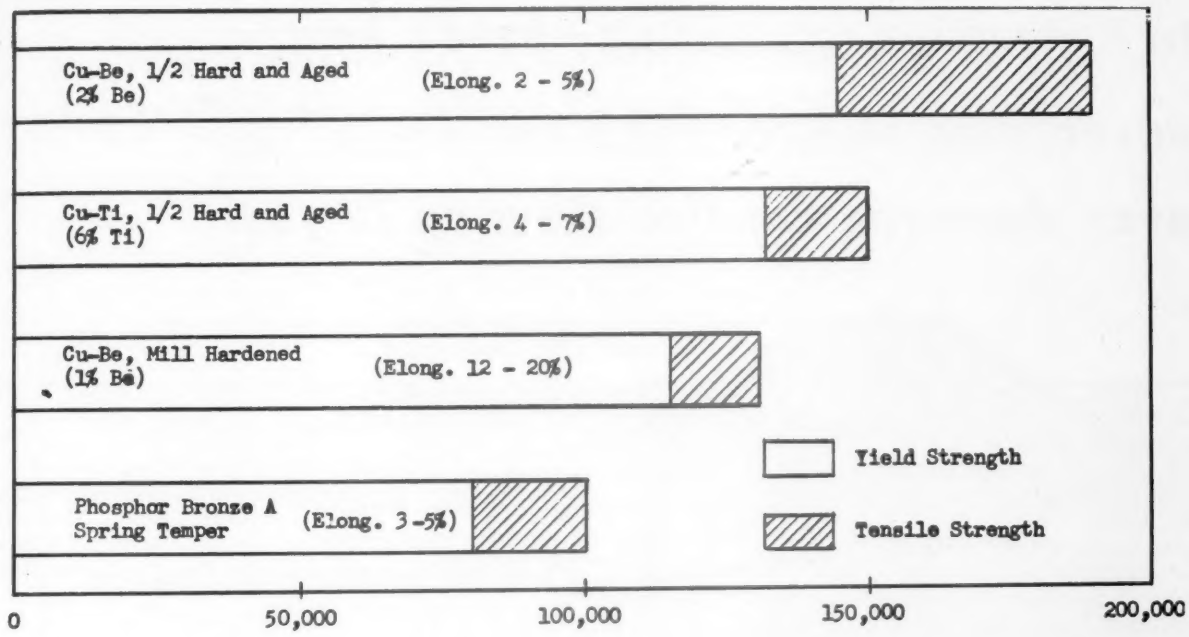


Figure 3. Nominal Tensile Properties of Several Wrought High Strength Copper-Base Alloys

radius of 0.040 inch and the ability to be silver flashed and successfully soldered. It would have been desirable, of course, to have processed some of the copper-titanium alloy directly from ingot to rod in preparation for the commercial wire processing. The laboratory equipment available, however, provided no practical means of doing so. As an alternative, some of the material was rolled to 0.250 inch thick strip and sectioned into what were essentially 1/4 inch square bars. The bars were cold swaged to 0.128 inch diameter rod and drawn to short lengths of 0.090 inch diameter wire. The lengths of wire were butt resistance welded into one continuous piece which was loosely coiled, solution treated and pickled in the laboratory. The wire was then turned over to a commercial facility which normally processes the standard copper-beryllium cord reel spring wire. The processing essentially duplicated that usually followed for the copper-beryllium wire with the exception of the temperatures used for "in process" softening and aging treatments. These were necessarily several hundred degrees higher. The silver flashed, finished flat wire (0.010 inch thick x 0.120 inch wide) was subsequently fabricated into switchboard cord reel springs by a manufacturer with previous experience in making the same springs from copper-beryllium. Both commercial facilities reported satisfactory response of the material to their usual processing.

* * *

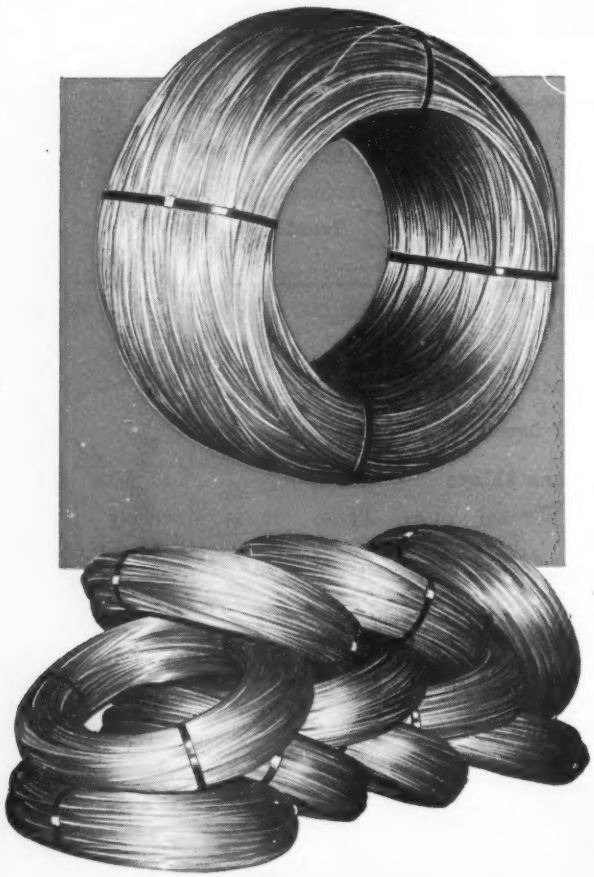
Since it cannot honestly be expected that simply subjecting an experimental alloy to a duplication of the processing established for a standard commercial material would lead to optimum performance, results of endurance tests conducted on this batch of springs were very encouraging. All but three of the eighteen springs tested met the endurance requirements established for the copper-beryllium springs. Subsequent metallographic examination revealed extreme overaging and a surface condition believed due to inadequate pickling. Both conditions would have a significantly detrimental effect on fatigue life. Thus, it is sincerely believed that with relatively minor modifications of the processing, completely satisfactory springs could have been produced. As mentioned previously, however, interest in a substitute for copper-beryllium alloys declined after the end of the Korean crisis and the work was discontinued.

* * *

In summary, then, it can be said that the copper-titanium alloy offers an attractive combination of high strength and good formability. The mechanical properties obtainable are such that the alloy could be considered a potential substitute for copper-beryllium in many of its applications, except, of course, those which utilize to the utmost the maximum strength or the electrical conductivity of the beryllium alloys. In addition to the properties and processing characteristics discussed in this paper, there are several other promising features which, if borne out by further studies, could well result in a copper-titanium alloy being economical-

(*Please turn to page* 1458)

In Brite Wire Fabricating—*here's how advantages of* DSC-Portsmouth LPR® Coils *over short-run bundles show up in your*



The LPR Coil at the top contains 2955 lbs. 11 ga. spring wire. It occupies a space of 24.5 cu. ft.

The 10 bundles in the lower picture weigh 3050 lbs. (also 11 ga. spring wire). They average 305 lbs. each and, even as "ricked", occupy a space of 90 cu. ft.

❶ space,
❷ handling,
❸ unit manufacturing
❹ and material costs

1-space: The pictures at the left show how the small bundles waste 65.5 cu. ft. out of 90 cu. ft. That's 72.8%. What's more, LPR's are self-supporting and readily accessible.

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4-unit material cost: The needless coil changes you avoid reduce the remnant scrap you generate by as much as 95%. As your yield goes up, your material cost per unit drops.

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Semiconductive Compounds for Wire and Cable Extrusion

by A. E. Tarbox
Development Associate
Union Carbide Plastics Company
Division of Union Carbide Corporation
Bound Brook, New Jersey

This paper was prepared for presentation at the Annual Convention of The Wire Association on October 25, 1961, at French Lick, Indiana.

Union Carbide Plastics Company has developed a new series of semiconductive polyethylene compounds which offer improved properties as inner and outer jacketing on communications and power cables where various degrees of conductivity are required. DFDA-0502 Black 55, DFDC-5275 Black 55 and DHDA-7800 Black 55 are based on a unique polyethylene resin which is capable of being loaded with large amounts of filler, in this particular case, conductive carbon black.

* * *

Introduction

The wire and cable industry has used so-called semiconductive materials in some specialized applications for many years. The most important use of this type material has been in the power transmission area where impregnated textile tapes or conductive elastomers are presently used as an interface between the conductors and the insulation, and between the insulation and shielding. For this application, the semiconductive material provides electrical stress relief and prevents deterioration from corona discharge. In the communications area, semiconductive materials have been used to replace metallic braid as an electrical interference barrier. More recently, communications cable designed for missile installations have called for the use of a semiconductive outer jacket as protection against lightning.

* * *

The increased interest in semiconductive for inner and outer cable jacketing, plus the recognition of property limitations in available materials, has created a need for improved semiconductive materials. Semiconductive vinyl and elastomeric rubber compounds have been found to exhibit poor low temperature properties. Vinyl compounds also require plasticizers, some of which in time migrate to the insulation, causing embrittlement of the jacket and failure of the insulation. Semiconductive butyl rubber must be supported by "Mylar" plastic and requires an outside waterproof jacket. The application of these materials in tape form requires the use of special equipment.

* * *

Each of the three semiconductive compounds differs in its degree of conductivity and other physical properties. The differences result from the ratio of carbon black to polyethylene resin, the type of carbon black, and the melt index of the resin. The properties of the three semiconductive compounds are shown in Table I.

Description of Materials

DFDA-0520 Black 55, with a volume resistivity of approximately 1.0 ohm-cm (as measured on a molded plaque), is the most conductive of the three materials. It was designed only for inner jacketing. DFDA-0520 is suitable for

TABLE I

COMPARATIVE PROPERTIES

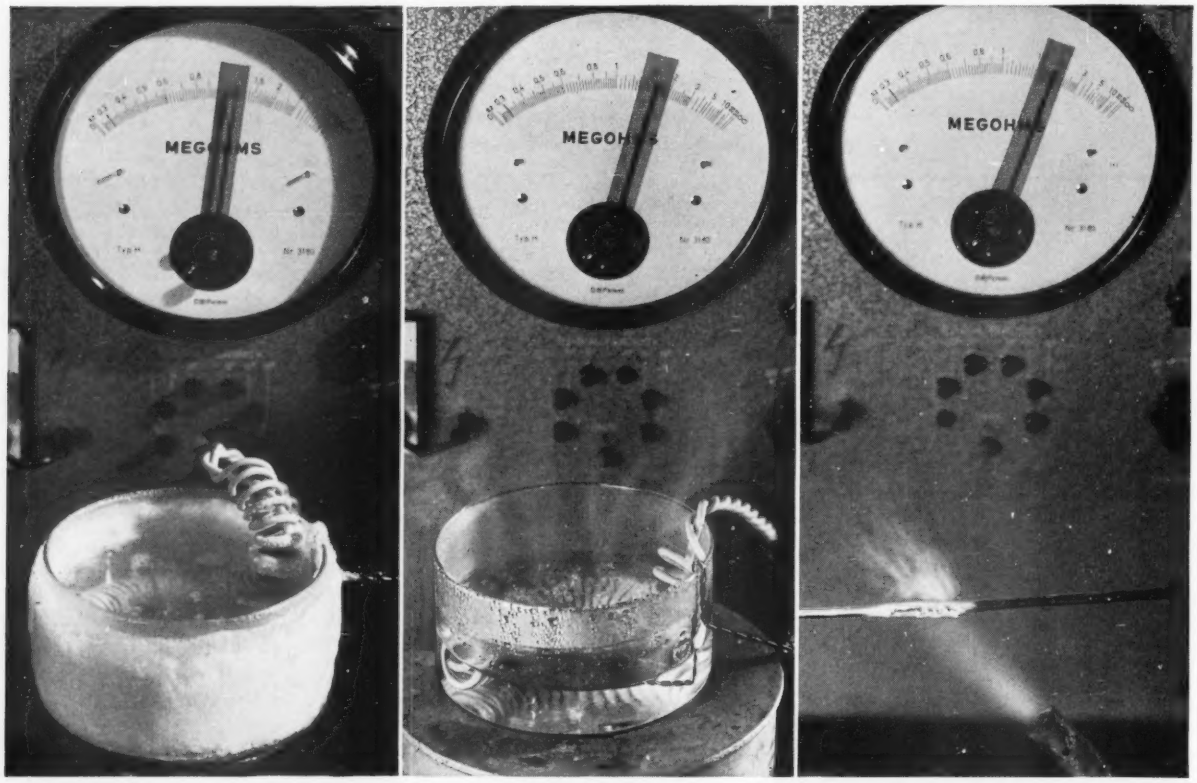
"BAKELITE" SEMICONDUCTIVE

POLYETHYLENES

Property	Units	ASTM No.	DFDA-0520 Blk 55	DFDC-5275 Blk 55	DHDA-7800 Blk 55
Density	gms/cc	D1505	1.17	1.12	1.13
Tensile Strength	psi	D412	1900	1900	2000
Elongation	%	D412	100	250	275
Yield Strength	psi	D412	1900	1900	2000
Brittleness Temp. 20% Fail	°C	D746	-30	-55	-55
Secant Modulus	psi	D638	39,000	21,000	24,000
Environmental Stress Cracking Resistance at 50° C. in "Igepal" CA-630	F_0 - hrs.	D1693	<1.0	>500	>500
Volume Resistivity at 23° C	ohm-cm	D257	1	5	40

SILICONE NEWS from Dow Corning

Frozen...boiled...burned

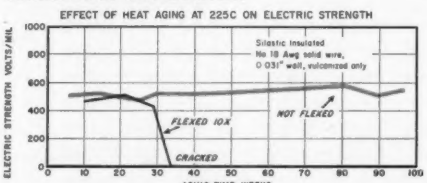


Silastic insulation maintains its properties from −90 to 500 F.

When mercury freezes, Silastic®, the Dow Corning silicone rubber, is still flexible. Fact is, Silastic insulation is ideal for temperatures as low as −90 F . . . easily withstands sleet, snow, ice and adverse weather you'd expect to find in the polar regions.

In a hot stew? Specify Silastic! Even 500 F has little effect on the properties of Silastic. That's why many industrial plants use Silastic insulated wire and cable. Strip mills, rolling mills, and metal forming plants (where high temperatures, humidity, chemical splash and fumes are common environments) are but a few of the installations using the properties of Silastic to provide cable dependability and long life.

To air-condition Hades would be a rugged assignment. However, if you were engineering the job you should specify power cables insulated with Silastic. Even if the Silastic burns, the ash is nonconductive. The line can carry a normal load as long as the ash remains intact and dry. This unique property of Silastic has been of primary importance in the protection of vital communication centers in both Navy shipboard and commercial installations.



Silastic insulation retains dielectric strength over a wide temperature span. What's more, its electrical properties are extremely stable and survive relatively unchanged even after long storage, weathering, thermal aging or heat cycling.

Write Dow Corning Corporation, Midland, Michigan, Dept. A722, for a list of wire and cable manufacturers who use Silastic.

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Cable Manufacturers, There's no need to stew...

A series of easy-to-use Silastic® compounds especially formulated for use as wire insulation is available from Dow Corning. These compounds provide the performance discussed in the adjoining advertisement, qualify for UL approved constructions, and meet Air Force and Navy cable specifications.

Easily processed on standard equipment, Silastic compounds require only a minimum of milling — and some can be fed directly to extruder from package. Silastic insulated wire is vulcanized by CV or by hot air, forming dense homogeneous dielectric walls for constructions ranging from hook-up wire to power cable. Braids and serves can be applied without further cure.

For FULL INFORMATION and TECHNICAL ASSISTANCE, contact Dow Corning Corporation, Midland, Michigan, Dept. A722.

use at temperatures as low as –30 deg. C. and is recommended as stress relief shielding in high-voltage cables. As a replacement for impregnated textile tape, it has the advantage of ease of application by extrusion which permits filling in the surface irregularities of the conductor. An inner jacket of DFDA-0520 Black 55 can also replace copper braid as an electrical interference barrier or as a cable ground against lightning, the discharge being drained off before causing short circuits.

* * *

DFDC-5275 Black 55 is designed as the more conductive of the two polyethylene cable jacketing compounds. The material has a volume resistivity of about 5 ohm-cm as measured on a molded plaque. This compound is recommended for external use as lightning protection on multiconductor cables because of its excellent stress cracking resistence (> 500 hours at 50°C. in "Igepal"), low temperature impact and flexibility (brittleness –55°C.) and good elongation characteristics.

* * *

DHDA-7800 Black 55 possesses a combination of properties which make it suitable for external jacketing where only moderately high conductivity (volume resistivity of approximately 40 ohm-cm as measured on a plaque) is required. This material also exhibits excellent stress crack resistance, elongation and low temperature properties. DHDA-7800 Black 55 differs from DFDA-5275 Black 55, the other external jacketing compound, by its lower conductivity and easier extrusion.

(At this point the author conducted a demonstration)

* * *

The variations in the conductivity of the three new materials can be best demonstrated by an apparatus consisting of a power source, a transformer and a fluorescent

(*Please turn to page* 1460)

TABLE II

RECOMMENDED EXTRUSION CONDITIONS

"BAKELITE" SEMICONDUCTIVE

COMPOUNDS

	2"-6" Extruder
Stock Temperature, °F.	365
Die Temperature, °F.[1]	250
Head Temperature, °F[1]	250
Breaker Plate Temperature, °F.[1]	250
Cylinder Temperatures Front, °F. Center, °F. Rear, °F.	 No heat 400-450 450
Die Design	Polyethylene type gradual approach, minimum land length to reduce shear.
Screw Design[2]	Constant depth, decreasing pitch, vinyl type screw.
Screw Control	Neutral
Cooling Trough	Trough must be close to die--cold water (40 to 70° F.)
Wire Preheat, °F	300
Screen Pack	None or coarse screens (#20 to 40)

(1) Maximum temperature recorded on short run.

(2) The screw should be designed to minimize shear.

The Processing of Steel into Cold Heading Wire

by Robert W. Davis
Superintendent, Bolt & Nut Products
Sheffield Division
Armco Steel Corporation
Kansas City, Missouri

I suppose that I have heard just about every kind of complaint made regarding wire rods and fasteners made from those rods. Though my experience as a bolt plant superintendent spans the short period of only three years, practically all of my working life has been spent in the fastener industry. As most of you know, we in the fastener industry have come a long way—and I hasten to add, have a long way to go. By this I do not mean that we have not made great strides. To the contrary, during the past twenty or so years, the people in the fastener industry have seen things done that were considered impossible and impractical from both a cost and production standpoint.

* * *

Steelmakers have progressed in a similar manner. I have had the privilege of watching this transition occur at the Kansas City Plant of the Sheffield Division, Armco Steel Corporation, and have shared in this progress with many fellow workers whose chief aim is to make better steel so we can make better rods and better wire, so we can make better fasteners. Our plant is one of the few which makes its own steel, rolls it, draws it into wire, and among other finished products turns out a full line of fasteners.

* * *

Though I realize that we will probably not have the opportunity to conduct many of you through our plant, it is possible to illustrate some of the processes we use to convert steel into rods and wire, with the ultimate objective of making bolts and bolt products.

Robert W. Davis

A paper prepared for presentation at the Annual Convention of The Wire Association on October 24, 1961, at French Lick, Indiana.

Mr. Davis joined the Sheffield Division, Armco Steel Corporation, as a summer employee in 1948. He continued part-time work in the Bolt and Forged Products Department of their Kansas City plant while continuing his education. Following his graduation from the University of Kansas, he worked as a mechanical engineer in their Works Engineering Department for several months before being re-assigned to the Bolt and Forged Products Department. There he worked as a tool engineer until being appointed superintendent in 1958.

* * *

The process begins when steel scrap and pig iron (Fig. No. 1) is unloaded at our plant. We have a special section in our purchasing department devoted solely to the purchase of scrap and raw materials. Before scrap is unloaded at the plant, it is checked by scrap inspectors and assigned to storage areas according to grade and analysis.

Figure 1.

* * *

From there it goes to the open hearth (Fig. No. 2) or electric furnace (Fig. No. 3), where it is melted down. In both the open hearth and electric furnace, the charge is selected and varied according to the type of steel being produced. Instrumental in controlling the melting and refining in both melt shops is the laboratory.

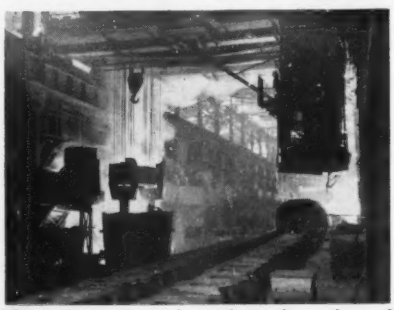


Figure 2.

Figure 3.

Samples are taken as melting proceeds and are sent to the laboratory through a pneumatic tube. Their exact analysis can be determined in a matter of

minutes and this information sent back to the melters working the furnaces. In making these analyses, our plant uses several types of spectrographic equipment. The direct reading spectrograph (Fig. No. 4) is capable of analyzing twenty elements from a steel sample. In a matter of minutes, it can determine the percentages of manganese, silicon, molybdenum, nickel, chromium, tin, copper, vanadium, and columbium in the sample. It also reads several less common elements.

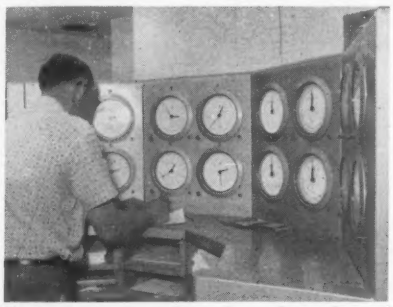


Figure 4.

In addition to the above, a second spectrograph, one which operates on the principle of burning a sample in an argon atmosphere and passing the light rays through a vacuum, is used to determine the amounts of carbon phosphorus, sulphur, arsenic, and boron present in the sample. This instrument can analyze up to twelve different elements. This equipment is complimented by a wet laboratory. The wet laboratory is used primarily to calibrate and control the spectrographs, but may also be used to analyze samples.

* * *

When the desired analysis is reached, the metal is tapped into ladles and then poured into ingots. Corrective additions may be made to the steel in the furnace, in the ladle, or after it has been teemed into molds. Ingots are removed from the molds at the soaking pits by a stripper crane and transferred to the pits. Here they are allowed to reach uniform temperature before being withdrawn (Fig. No. 5) and sent on to the blooming mill. I might add here that the ingot size with which I am most

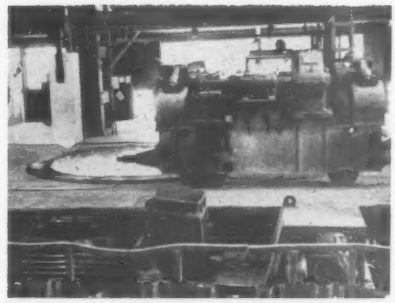


Figure 5.

concerned — the one that ultimately winds up as cold heading wire — measures 21″ x 23″ x 74″ and weighs approximately 8,100 pounds.

* * *

Ingots are first rolled (or reduced) on a two-high, reversing blooming mill (Fig. No. 6). Without re-heating, they are then rolled into billets (Fig. No. 7) on a six-stand, continuous billet mill.

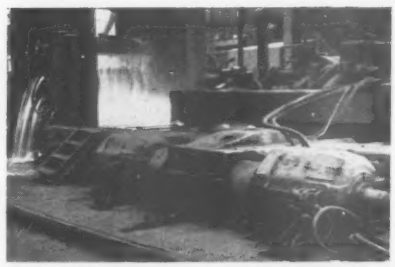


Figure 6.

Figure 7.

Billets for the rod mill (Fig. No. 8) are sheared to 40-foot lengths. The rod mill is a 23-

Figure 8.

stand, high-speed mill which was placed into operation in 1959. Billets 2-3/4″ square, weighing 1,000 pounds, are used on the rod mill for 5/8″ diameter and smaller rods. Billets 3-5/8″ square, weighing 1,500 pounds, are used for rods over 5/8″ diameter. On this rod mill, sizes 7/16″ diameter and under are triple stranded. Rods 29/64″ to 11/16″ are double stranded, and rods 11/16″ and over are run single strand. After the rod leaves the finishing stands, both water and air cooling may be used to control scale formation and the physical properties of the rod. This mill is equipped with both pouring reels and laying reels.

* * *

Rods for fasteners may be further processed in either the wire mill or the bolt plant. Batch-type furnaces for the spheroidizing or annealing of stock are used in the wire mill. A continuous pusher-type furnace for the treatment of bolt stock is used in the bolt plant. In both the wire mill and bolt plant, the equipment may be operated with an atmosphere to retard decarburization or restore carbon to the rods. Acid cleaning is used in the wire mill and either a lime or phosphate coating is applied to the cleaned rods. Next the rods are welded together before being drawn on a dead block wire drawing machine (Fig. No. 9). This particular unit delivers a continuous wire, weighing approxmately 2,500 pounds onto a high hat.

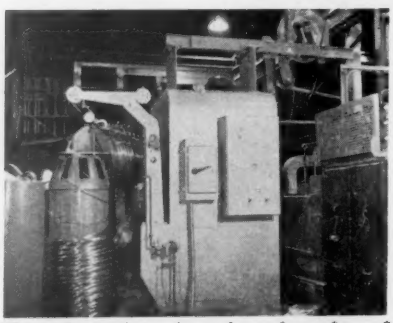
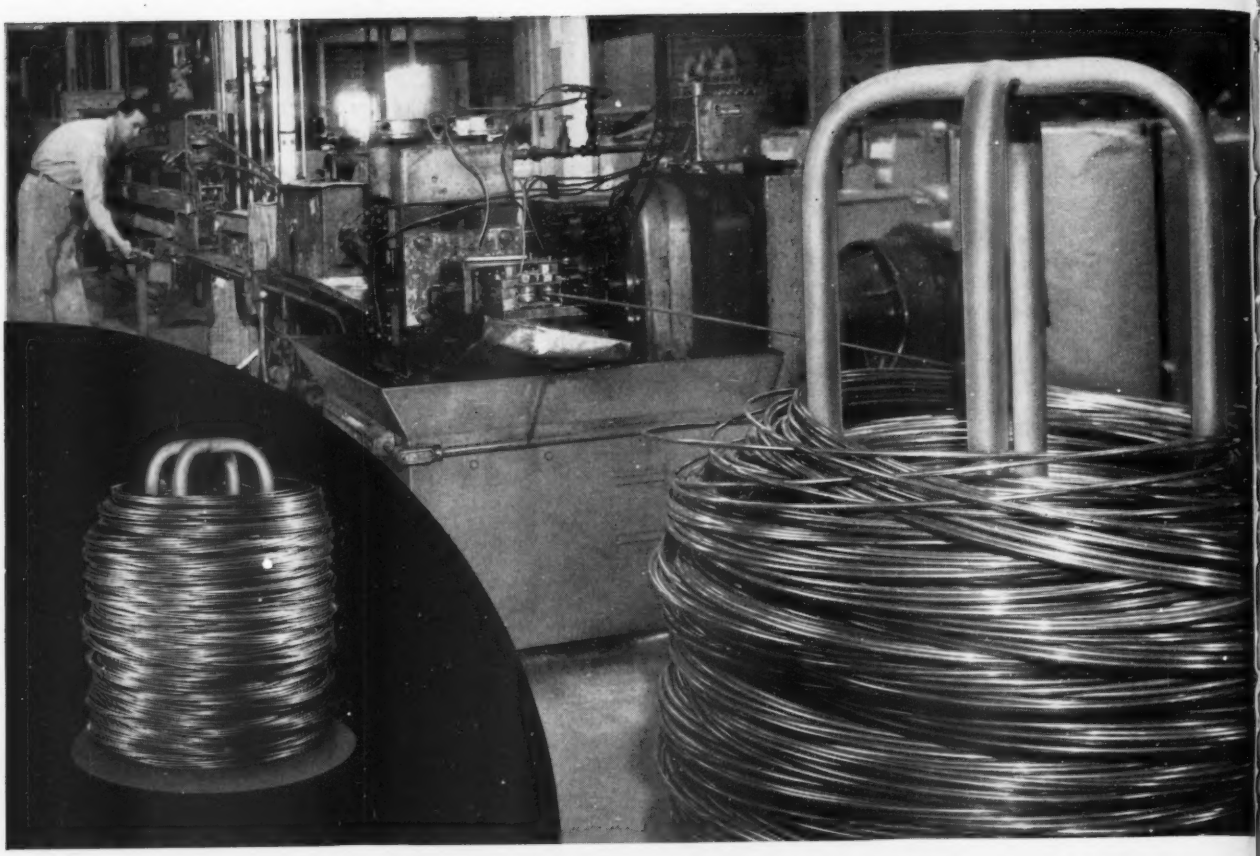
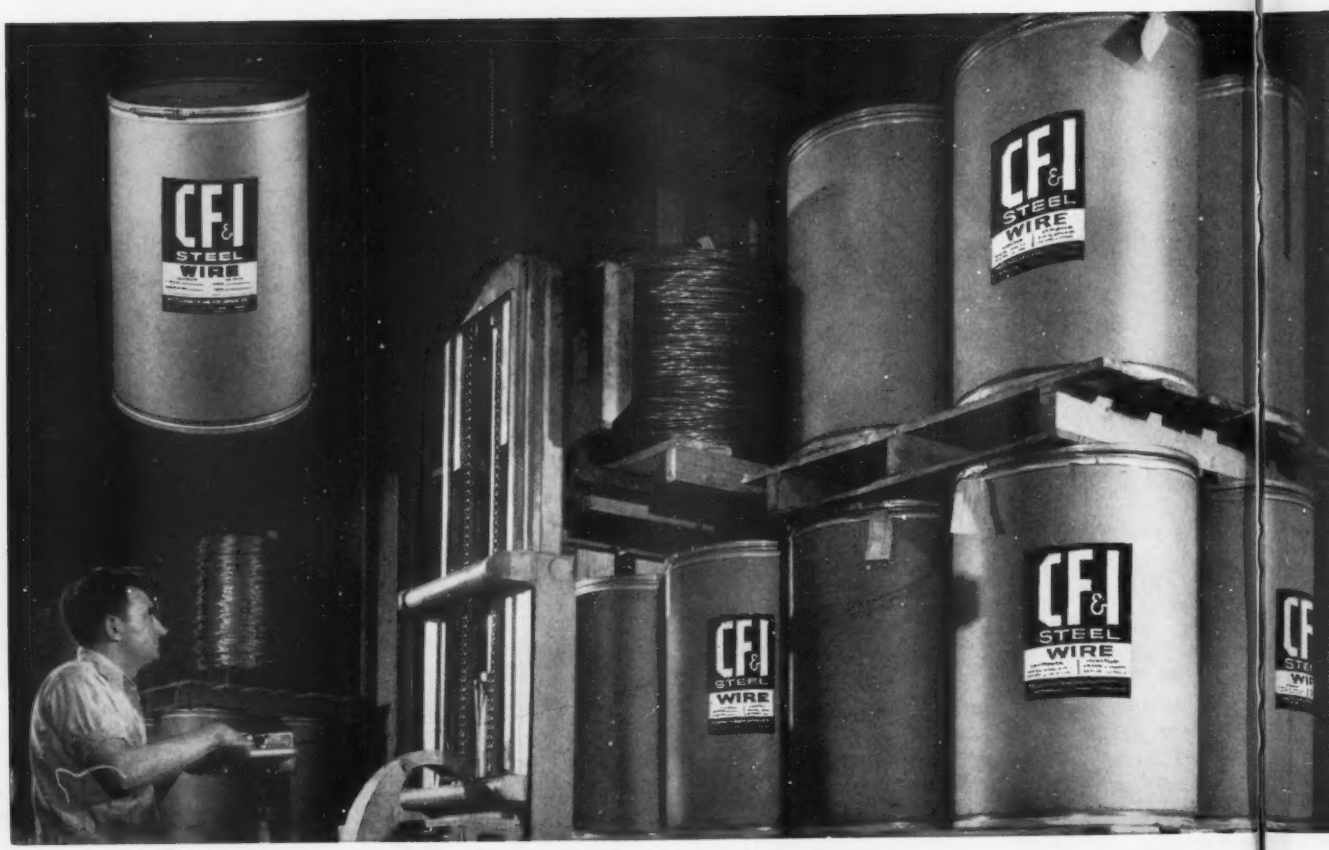


Figure 9.

In the bolt plant, rods are shot blasted to remove scale, then coated with phosphate and drawn into wire on continuous

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RETURNABLE SPIDERS

Here's the experience of one typical user:

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CF&I-Wickwire Returnable Spiders hold 2000 to 3000 lbs. of wire in one continuous length . . . consist of a center core welded to a heavy base plate. Available in two standard types from our mills—with core diameters of 18″ and 22″.

OPERATING ADVANTAGES: Increased production, decreased labor, less scrap loss, ease of handling and improved quality of end products.

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Here's what one satisfied user said about CF&I Fibre Drums:

> "They're an answer to the problem of unclean wire. The metal cover and locking band protect the wire from grime and other corrosive elements. The fact that they hold up to 600 lbs. of wire in one continuous length enables us to run our machines for a longer time than when we used small coils."

Fibre Drums hold 250 to 600 lbs. of wire in one continuous length . . . consist of a sturdy fibre container with center core, metal cover and locking band which protect the wire from atmosphere and dirt. The wire is directly withdrawn from the drum into your equipment. Available in full and half drums.

OPERATING ADVANTAGES:

- Cleaner wire, because the sealed drum protects the finish on the wire.
- Increased production, because of smooth pay-off and the fact that your machines have less downtime than with conventional coils.
- Less storage space required, because Fibre Drums can be stacked compactly on each other.
- Quick, easy handling . . . drums can be shipped strapped to a wooden pallet for convenient handling by a fork-lift truck.

ONLY CF&I OFFERS A TOTAL OF TEN DIFFERENT WIRE PACKAGES. You've just read how two of these packages have increased the production efficiency of leading manufacturers. One or more CF&I-Wickwire Wire packages can do the same for you. Our engineering staff will be happy to study your operation and recommend the type that best meets your requirements. For complete details, write your local CF&I sales office.

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lines. Then it is stored (Fig. No. 10) near the boltmaking equipment. This, then, is a brief presentation of the processes and facilities used in our plant to produce wire for cold forged products.

Figure 10.

The steps followed in the production of various types of forging rods are generally similar but differ from each other in many important details. For the production of the common type of cold headed fasteners such as would meet the specifications of ASTM A-307 and SAE Grades 1 or 2, a capped steel is used. A typical analysis for this material would be .15 carbon, .35 manganese, .02 maximum phosphorus, and .035 maximum sulphur.

* * *

With this capped steel a rimming action occurs in the molds during teeming and for a period after. As the molten metal lies in the mold, the carbon and oxygen contained in it react to form carbon monoxide gas. Mold additions of sodium fluoride, aluminum shot, or commercial rimming agents are made to promote and regulate the rate of gas evolution. Gas evolution is also a function of temperature and pressure. As the temperature of molten steel drops, the solubility of entrapped gasses decreases and, therefore, gas evolution is increased. Higher pressures will decrease gas evolution. The gas formed in the ingot rises to the top causing a bubbling action on its surface. When solidification of the metal starts where it contacts the mold, the gases rise through the relatively fluid metal which remains leaving an iron rim which contains very few impurities. At the proper time a steel plate, or cap, is placed on the surface of the ingot. This causes an increase in pressure within the ingot with the result that gas evolution ceases. Some gas remains in the ingot in pockets called blowholes.

* * *

As rolling proceeds as described above, these blowholes are welded shut. Should any of them extend to the surface of the ingot and their surface become oxidized during heating, they will not weld shut and will show on the surface of the finished rod as a seam. The gases evolved during the rimming action help to counteract the tendency of the metal to shrink in the center and thus form a hollow cavity or pipe at the upper end of the ingot. Nevertheless, extra caution is taken at the shears in the billet mill to assure sound billets from the top portion of the ingot. Standard practice is to divert 15 per cent from the top of the ingot. Billets are visually inspected and all defects marked following which they are scarfed to remove surface imperfections. The rim formed on the ingot is maintained through the rolling operations. As finished off the rod mill, this material will have a tensile strength of 50,000 to 55,000 p.s.i. The scale is normally one to one and one-half per cent. Finishing off the mill at low temperatures and using maximum cooling will reduce the scale as low as .6 per cent. Under this latter condition, the tensile strength of the rod is raised about 3,000 p.s.i.

* * *

For the production of medium carbon bolts, such as those to meet ASTM Specification A-325, or SAE Grade 5, a semi-killed steel with a typical analysis of .38 carbon, .85 manganese, .03 maximum phosphorus, .025 maximum sulphur, .10 silicon, and . 30 maximum copper is used. Because semi-killed steel tends to have more surface imperfections than rimmed steel, more careful attention is paid to surface conditioning. All visible surface defects are removed by hand scarfing. No billets showing pipe on the sheared ends are used for cold forging rods. Any heat which is observed to have an inferior surface when rolled is applied to products where surface is not as critical as in cold forged products. As rolled, this material will have a tensile strength of 85,000 to 90,000 p.s.i. This may drop to 70,000 to 80,000 p.s.i. after spheroidizing and return to the 85,000 to 90,000 p.s.i. range after being drawn into finished wire.

* * *

Wire for the production of nuts by the cold-forming process is produced to have special characteristics. It must form easily so the pressure on the forming tools is kept low to produce the maximum number of nuts at the lowest possible tool cost. It must have a surface free from defects so the finished nut blanks do not contain cracks which detract from the appearance and might structurally weaken the nut. It must be free machining so the nut blanks can be easily tapped, once again holding tool cost to a minimum.

* * *

Steel for this application might be expected to have an analysis of approximately .09 carbon, .50 manganese, .02 phosphorus, .10 sulphur, and .30 copper. The low carbon contributes to ease of forming. A tensile strength of 50,000 to 55,000 p.s.i. is normal for this material as rolled. A tensile strength of 65,000 p.s.i. would be representative for wire of the above analysis. Even so, the strenuous cold work performed on this material raises the physical properties to the required levels in the finished product. The nuts produced from such wire will meet a proof load corresponding to a tensile strength of up to 120,000 p.s.i. in their mating externally threaded members, depending on type of thread and style of nut.

* * *

A capped steel having the

(*Please turn to page* 1461)

Controlling Quality of the Surface of Wire by Nondestructive Tests

by Henry G. Bogart
Branch Manager
Magnaflux Corporation
New York, New York

As an introduction to the subject of nondestructive testing, as applied to wire and wire products, let us first take a look at some basic considerations in the use of inspection methods in general and nondestructive testing in particular.

* * *

What purpose do we seek to accomplish when we set out to use any inspection process? The obvious answer is that we seek to make sure that the end-product is of good quality, so that it may satisfactorily fulfill its intended service function. On the other hand, there is no need for the product to be any better than that and the emphasis should be on the word "control" rather than on the word "quality". Nondestructive testing, if intelligently applied, is not used to aimlessly improve quality but to achieve a consistent level of quality and, with it, product reliability.

* * *

Unquestionably, these are objectives of prime importance and nondestructive testing is justified on these grounds alone. But an analysis will readily show that testing methods, intelligently chosen and applied, can accomplish important cost reductions, which often more than make up for the cost of the test.

* * *

For example, testing applied to raw material can prevent unsuitable or defective material from ever starting into the production process. This is one of the most important points at which cost savings can be made since defective material is then detected before costly processing operations have been performed on it. Furthermore, by detecting defective raw material before processing, it is much easier to bring about an early improvement in the source of supply.

* * *

A second example is the testing after certain manufacturing processes to detect defects introduced by the processes in order to be able to take prompt corrective action. At this point, testing may sometimes be done on a statistical sampling plan. Here again, important cost savings are possible, by preventing the spoilage of additional material and by preventing the defective material from going further in the production process.

* * *

Henry G. Bogart

This paper was prepared for presentation at the Annual Convention of The Wire Association at French Lick, Indiana, on October 24, 1961.

The author received his science education in European schools and training in business administration in the U.S.A. He has been with Magnaflux Corporation for 17 years, 8 as a field engineer, 8 as Assistant District Manager, Eastern District, and one as New York Branch Manager.

Among the most effective nondestructive testing methods available to modern industry is magnetic particle inspection.

* * *

The late Prof. A. V. DeForest, a pioneer in this field, and a founder of Magnaflux Corporation, always said that nondestructive testing should be carried out as close to the hot steel as possible. Today, the steel industry is, to an ever increasing extent, practicing what he preached.

* * *

Magnaglo is used by American Steel & Wire to inspect billets prior to conditioning at two important mills. At one of these, at Worcester, Mass., 2 x 2 billets are 100% inspected at a rate of 2 per minute on special, automated, heavy duty equipment:

Storage rack and unscrambler, U. S. Steel, Worcester. (Fig. 1)

Magnetization and Bath Application, U. S. Steel, Worcester. (Fig. 2)

Inspection under Black Light and Marking of 4 x 4 billets at Cuyahoga Works, U. S. Steel (Fig. 3)

12 x 12 billet turner & Inspection Station, Copperweld Steel Co. (Fig. 4)

Defects marked with chalk. (Fig. 5)

Unloading & Sorter, Worcester, Mass. unit of American Steel & Wire. (Fig. 6)

Conditioning by chipping out seams. (Fig. 7)

* * *

Many other mills have studied Magnaglo inspection of billets and several are in the process of implementing it.

* * *

The question of what to do with billets showing indications can be answered only by a study of the rolling schedule. Sometimes billets with seams can be used for less critical

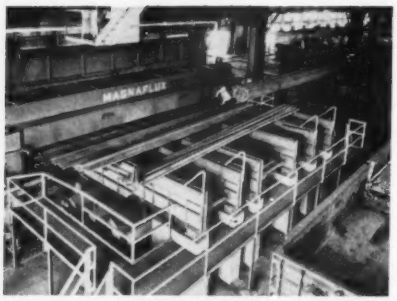


Fig. 1 — Type X-2110 Installation at The Worcester, Massachusetts Works of American Steel and Wire Division, U. S. Steel Corporation. * * * * * * * *

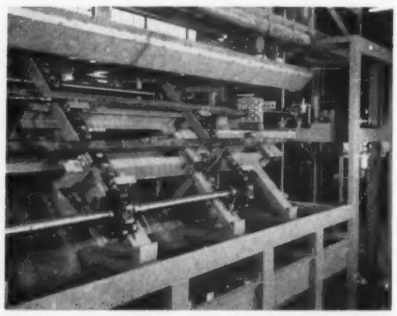


Fig. 2 — Magnaflux Type X-2110 square billet unit for The Worcester, Massachusetts Works of American Steel and Wire Division, U. S. Steel Corporation. * * * * * *

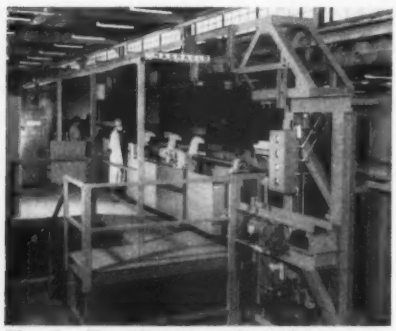


Fig. 3 — Magnaflux-Magnaglo billet unit for testing ranges of sizes of square billets from 2-5/16" to 4¼" square, up to 40 ft. in length. American Steel & Wire Division, U. S. Steel Corp., Cuyahoga Works, Cleveland, Ohio. *

Fig 4 — Type X-2246 Magnaglo Unit. Square billet turner and inspection station. Copperweld Steel Corporation. * * * * *

applications, at other times, the seams can be removed by chipping or flame gauging. If they

Fig. 5 — Type X-2246 Magnaglo Unit. Square billet turner and inspection station. Shipped to Copperweld Steel Corporation. * * *

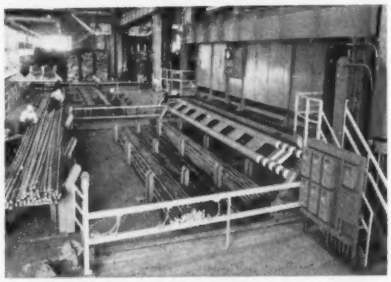


Fig. 6 — Magnaflux Type X-2110 square billet unit for The Worcester, Massachusetts Works of American Steel and Wire Division, U. S. Steel Corporation. * * * * * *

Fig. 7 — Magnaflux Type X-2110 square billet unit for The Worcester, Massachusetts Works of American Steel and Wire Division, U. S. Steel Corporation. * * * * * *

are not too deep, they can be ignored since they will "scale-off" during the hot rolling operations.

* * *

Figure 8 shows how the Magnaglo indications can be used to judge the depth of the seams they indicate. Note how much heavier and more brilliant the indication due to the .205 deep seam, compared to the two shallow ones.

* * *

Here is a hot rolled alloy steel bar with a Magnaflux indication due to a cooling crack. Cross sections at points "a", "b", "c" show once again the

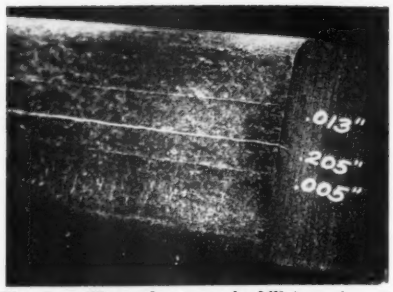


Fig. 8 — Magnaglo seams in billet. * *

correlation between the indication and the depth of the defect. (Figs. 9 & 10).

Fig. 9 — Cooling cracks in hot-rolled alloy steel bar — indicated by Magnaflux. * *

Fig. 10 — Section of hot-rolled alloy steel bar showing varying depth of cooling cracks. *

The next point, at which nondestructive testing is carried out, is on the finished wire. Magnetic particle inspection of the finished wire is costly and time consuming. Where it is used, it is limited to sampling of the ends of coils.

* * *

Electronic testing of wire, on the other hand, is fast and relatively inexpensive. The operation is not dependent on an op-

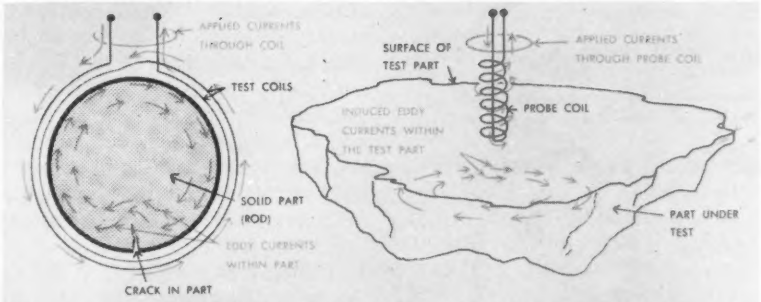


Fig. 1. A part is passed thru a test coil. The applied current in the coil induces eddy currents within the part. These are affected by a crack, or other change in the part.

Fig. 2. Electric currents in the probe coil induce eddy currents within the test part. These react back on the applied current, for "read out".

Fig. 11 — Eddy currents test metals on the production line. * * * * * *

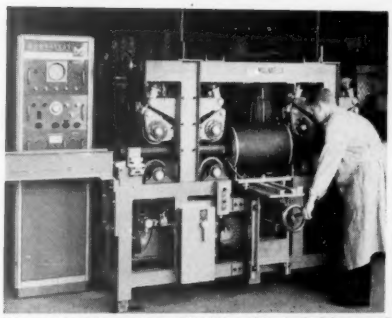


Fig. 12 — Magnatest SD-100 with DC bias and special tube feeder. * * * * *

erator and equipment is used which automatically marks the defective areas for subsequent removal.

* * *

The theory of this newer method relies on eddy currents, set up in the wire by means of a coil carrying a high frequency electric current. The wire passes through this test coil and variations in the eddy current caused by various discontinuities and inhomogeneities are detected with a pick-up coil. (Fig. 11).

* * *

In any nondestructive test, such as eddy current testing, a great deal of information can be picked up by the testing device and, if the equipment is electronic, this information can be amplified and reamplified at will. Theoretically, there is therefore no reason why even the smallest discontinuity cannot be picked up by such methods. However, as we amplify signals from the smaller discontinuities, we aiso amplify signals due to various irrelevant conditions; in the case of ferrous wire those may include slight changes in diameter, local cold working, small differences in hardness, etc.

* * *

If quality were the only consideration, the problem would be rather simple: We would simply reject all material shown to have variations, regardless of whether or not these changes have a significant effect on the useful life of the product. Only a small amount of the raw material would be used, and this small amount would certainly be free from harmless flaws. Of course, this wasteful procedure is economically impossible.

* * *

If we call the significant indications "signal" and the insignificant types "noise", then we might say that what we are striving to do is to improve the signal to noise ratio. To do this, we have five techniques, each approaching the problem in a different manner, and all operable jointly, so that they aid each other.

* * *

a - First, we have the choice of working either predominantly on magnetic phenomena or primarily on changes in conductivity.

* * *

There are certain advantages in working with conductivity changes rather than magnetic disturbances, because one often finds a great many changes in permeability along the length of wire, which are not connected with flaws; in this category are changes in permeability due to minor changes in hardness due to cold working, and the like. We can overcome the permeability variations, by saturating the wire with a heavy magnetic field, thus bringing the effective permeability to zero. (Fig. 12). This is done by means of high amperage DC current. The current is fed to a water cooled coil, surrounding the wire at the test point. Thus, it is possible to limit the read-out to variations in electrical conductivity.

* * *

b - Of course, this set up would require continuous rebalancing, as slight changes in conductivity often occur along the length of the wire. (Fig. 13). These changes may be due to minor changes in diameter, quite within the tolerances of the wire, minor changes in chemical composition, or even changes in temperature. These insignificant variations can be ignored by means of a simple device, called "the differential coil system". Instead of having one pick up or test coil, two test coils are employed, close to each other. The two coils are connected in series opposition, so that their combined output is zero, as long as the material running through them is alike. Minor variations in diameter, hardness, temperature or chemical composition occurring gradually along the length of the wire will therefore affect both coils equally and will not result in a signal. A flaw, on the other hand, will first affect one coil and not the other, thus unbalancing their output and actuating the flaw alarm. As the defect leaves the coils, it will again first leave one coil and then the other, and once again, the balance between the test coils will be upset and the flaw alarm triggered.

* * *

c - The frequency at which the exciting coil is driven is also of importance. The frequency, conductivity and diameter determine the penetration

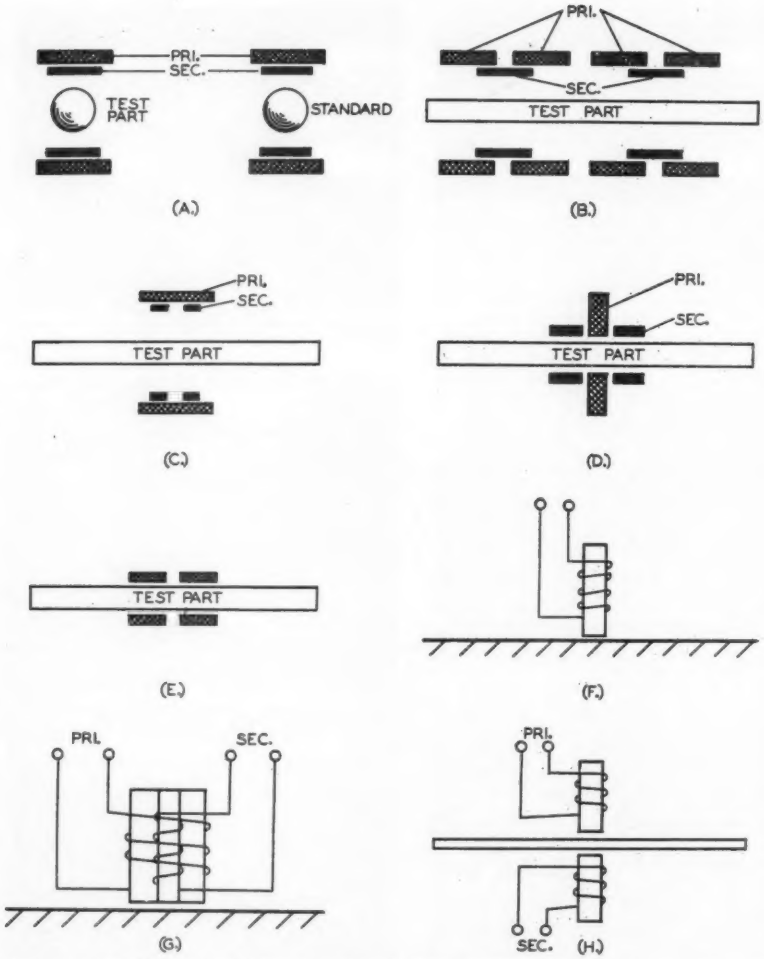


Fig. 13 — Examples of feed-through and probe-type inspection coils. * * * *

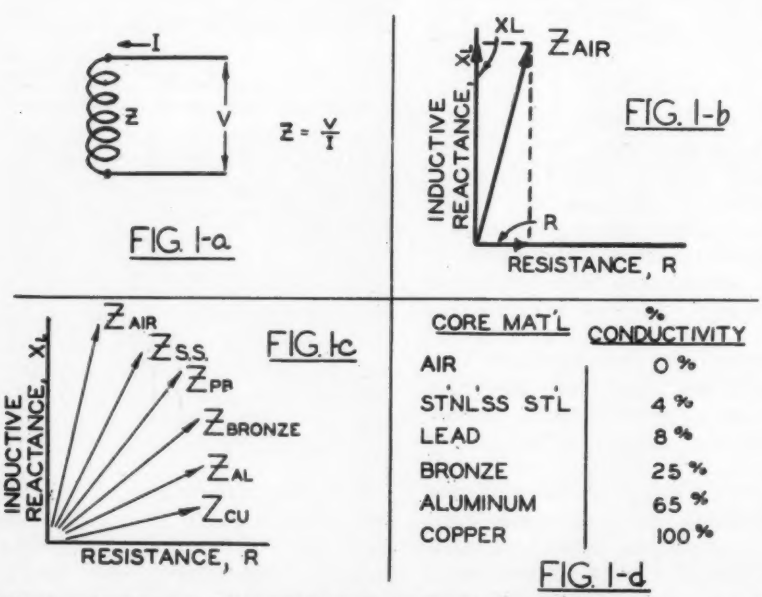


Fig. 14 — Impedance of a test coil in air and with various core materials. * * *

of the eddy currents into the cross section of the wire. Penetration can therefore be controlled by proper frequency selection for any given diameter and conductivity condition. Fortunately, the exact frequency is not critical and it is adequate to control the exciting frequency in multiples of 5. Thus, 1 KC, 5 KC, 25 KC and 125 KC are the most widely used test frequencies. * * *

But there is one other reason why it is important to control the test frequency: The changes which occur in the test coils are called "impedance" changes. Each impedance change can be broken down into two components: A reactive component, and a resistive component. The overall, or amplitude of the impedance change is a vector of these two. If the proper frequency range is employed, an analysis of the impedance change can reveal additional important data.

* * *

d - This brings up the subject of phase discrimination. By means of phase discrimination, we not only determine the amplitude of the overall impedance change, but also its direction on the impedance plane. (The impedance plane is the area encompassed by the two components, the reactive and the resistive components, which act at right angles to each other). (Fig. 14). An example of how phase discrimination helps, can be cited by this analogy: Suppose we hear that someone we want to find has traveled 50 miles on a certain day. If all we know is the starting point, we would have to search for him in a 50 mile radius. On the other hand, if we also had information as to the direction of his travel, our search would be much simpler. Phase discrimination shows us the phase angle, or direction in which the impedance change takes place and therefore can give much more precise information about the condition which caused the signal.

e - After the signal has passed through all these screening devices, it still contains a number of "pips" due to a variety of insignificant discontuities, such as perhaps, an accumulation of shallow scratches, whose combined effect may result in impedance changes larger than those produced by small, single cracks or seams. (Fig. 15). A filter is used to differentiate between these conditions. If I am permitted to use another analogy, I would compare the working of a filter

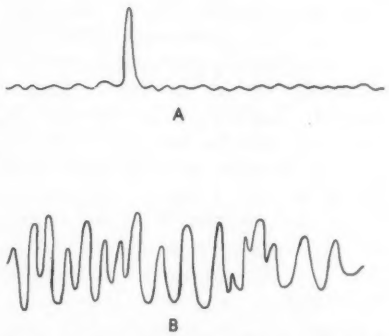


Fig. 15 — Signal-to-Noise Ratio — Illustrates how a test signal (Figure A) can be masked by irrelevant noise on an eddy current test (see Figure B). This background noise is due to the fact that eddy current instrumentation may be sensitive to variables other than the one of interest. This may require special techniques or auxiliary instrumentation to improve the signal-to-noise ratio. * * * *

circuit to the problem confronting a P. T. A., trying to control the attendance at a grade school dance. If we assume that the school had a guard with zero intelligence, and this guard was instructed to pass only persons of a certain maximum height, he would probably be able to keep out the teenage gate crashers—but he would also keep out the members of the P. T. A. running the affair. If he were told, however, to pass those taller persons who showed a P. T. A. card, he would be doing a more effective filtering job. Something of this sort is done in the filter panel of the SD-100. Each impedance change not only has a certain amplitude and direction, but also has certain characteristics, particularly in the manner in which it occurs in respect to time. Some changes occur more rapidly and othere more gradually and, by knowing which are significant and which are not, it is possible to set the filter to reject only the significant variations and to ignore the others.

* * *

We tied these technical ends together in our SD-100 Magnatest unit and added a spray gun to paint the defective areas. The Associated Spring Corporation's Research and Development Center in Bristol, Connecticut, took one of these units and developed the techniques necessary to adapt it to their particular production application, the inspection of automotive valve spring wire. **Mr. Gerson M. Jacobson,** Development Engineer of A.S.C.'s Research and Development Center, in a letter dated February 28, writes:

* * *

"We have been in experimental operation for quite a few months now and have processed better than 150 bundles of valve spring wire in sizes from .169" diameter to .207" diameter. Over 3/4 of the wire processed has been used on a critical production job at our B-G-R Division plant in Ann Arbor, Michigan. To date, wire inspected on this equipment and found to be satisfactory, has gone a long way to insure product reliability. Areas of wire containing defects indicated on the equipment have been culled out during the fabrication process and have been found to contain surface defects, some of which would be either detrimental to fatigue properties or undesirable from general service use.

* * *

"By means of monitoring both magnitude and phase simultaneously on two channel Brush Recorder, we have been able to detect the beginning and ending of artificial seams, and to differentiate them from what we refer to as point defects, such as pits, slivers, nicking of wire, and other such defects that would occur essentially over a very small area versus the seam which would have some length."

Mr. Jacobson further reports that: "The Associated Spring Corporation, for the first time in the spring industry, has placed high-speed flaw detection of valve spring quality wire on a production basis. The Magnatest unit tested at the Research and Development Center and newly designed wire handling equipment, operating at just under 500 feet per minute have been installed at our B-G-R Division in Plymouth, Michigan. On May 5 full production inspection of incoming material was underway. A new Magnatest unit has been ordered by the Research and Development Center for application to the detection of flaws in smaller sizes of wire required in other critical fatigue applications".

* * *

"I am enclosing four Polaroid shots of a wire flaw (see Figs. 16, 17, 18, and 19) (pitted wire to be exact) that had been detected by the Magnatest unit.

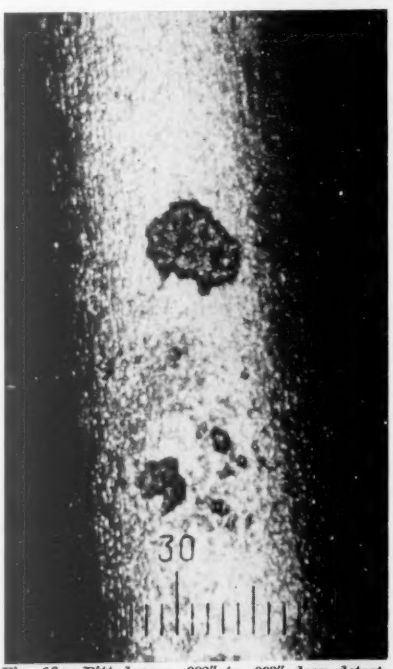


Fig. 16 — Pitted area .002" to .003" deep detected with Magnatest flaw equipment on surface of .187" diameter tempered valve spring wire. Original magnification 15X — unetched. * Photo: Courtesy of Associated Spring Corporation.

There are also pictures of the fracture showing the propagation from the pitted area. I am quite sure you will be interested in

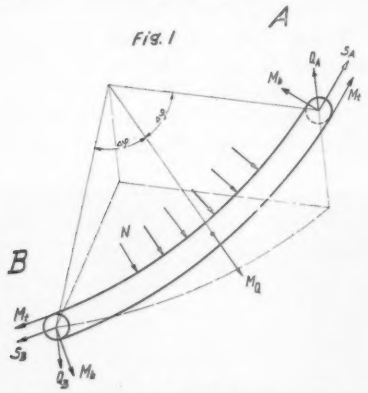
(*Please turn to page* 1466)

Variable Back-Twist in Rope Making Machinery

by Hans-Werner Schinke, Dipl. Ing.
Chief Engineer
Fried. Krupp Maschinen- und Stahlbau
Rheinhausen, Germany

During the stranding of wires and the closing or laying up of strands the wires are subject to a number of stresses. Due to the position of the wire in the strand, forces and moments are produced which result in a permanent or elastic deformation (Figs. 1 and 2).

Fig. 1



The wire is positioned in the rope in a special twist. The wire is being bent whilst being simultaneously subject to a torsional stress. With a view to simplifying the degree of the backtwist let us imagine the rope making process and the resulting backtwist in a simplified manner. It will be suitable to consider the two extreme limits.

* * *

In the first limit case the wire is wound round the core at a stranding angle of 0°, that is to say, a winding embraces the core in a circular manner. During this operation the wire is only subject to a bending stress and the detorsion (back-twist) for this winding is equal to 0.

* * *

In the second extreme limit case the same wire is wound round the core at a stranding angle of 90°, that is to say, with a length of lay ∞ ; in other words a winding is infinite, and the wire is approximately parallel to the core, and the detorsion (backtwist) is 360°. The aspect of the second limit case is best illustrated if we imagine an infinitely thin thread-like cylindrical core with a stranding angle of 90°, the wire is once wound round itself so as to obtain a full torsion of 360°. Hence it follows that the backturn angles used in practice have to be between 0 and 360° twist. As in general the stranding angle is within 45 to 90°, the twist of the wire and the required backturn resulting therefrom are nearly 360°. Although most of the customary stranders are equipped with a constant backtwist device of 360°, often a variable backtwist is adopted in order to ensure an exact reduction of torsion or freedom from moments. I have, therefore, based the method of computation on stranding equipment fitted with a continuously adjustable backtwist.

* * *

Hans-Werner Schinke

This paper was prepared for the Annual Convention of The Wire Association at French Lick, Indiana, in October, 1961, but was received after the Program Committee had completed the program and was not included in the papers to be presented.

The author is Chief Engineer of the Cable, Sheathing Press and Wire Drawing Equipment Department. He attended the Institute of Technology in Munich and received his degree in 1945. He first was active in the machine tool industry and then spent six years with Felton & Guilleaume Carlswerk A. G. at Koeln-Muelheim, after which he joined the Krupp organization in 1954. Here Mr. Schinke developed the stranding machine department to include wire drawing machines, cable and cabling machinery, and cable sheathing presses.

Based on the vector calculus of **W. Beindorf,** following the statements made by **H. Horn** and deriving the torsion angle from the diagram shown in Fig. 1 (Table of Symbols), as well as referring to the above mentioned forces, the torsion angle δ of the wire can be computed by means of the differential geometry as follows:

$$\text{I.} \qquad \frac{1}{\delta} = \frac{\sin^2 \alpha}{c}$$

* * *

Introducing the length of arc L we thereby obtain the torsion angle of the wire arc

$$\text{II.} \quad \Theta = \frac{1}{\delta} \cdot L = 2\pi \cdot \sin \alpha = 360^\circ \cdot \sin \alpha$$

* * *

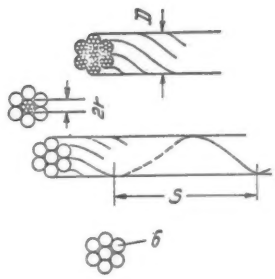
Using the above formula and adopting the machine backturn angle per revolution of the strander $= \sigma$, we thus obtain the resulting torsion angle of the wire per lay:

$$\text{IIa.} \quad \Theta = (2\pi \cdot \sin \alpha) - \sigma$$

* * *

In conclusion (after a lengthy mathematical procedure), we obtain from the application of the above derivation, and considering that the ideal backtwist angle compensates in unloaded state the moments (residual moments) occurring in the wire, the back-

Fig. 2



D = Diameter of Rope

r = Radius of Core Wire

S = Length of Lay

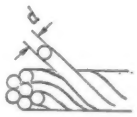
$c = \frac{S}{2\pi}$

n = Number of Wires

G = Shear Modulus

$J_p = \frac{\pi d^4}{32}$ = Polar Moment of Inertia

d = Diameter of Wire



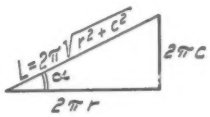
$e = \frac{r^2}{c^2}$

α = Angle of Pitch

$\sin\alpha = \frac{c}{\sqrt{r^2+c^2}}$

$\cos\alpha = \frac{r}{\sqrt{r^2+c^2}}$

$L = 2\pi\sqrt{r^2+c^2}$



$\frac{1}{\phi} = \frac{\sin^2\alpha}{c}$

$\theta = \frac{1}{\phi} \cdot L = 2\pi \cdot \sin\alpha = 360° \cdot \sin\alpha$

$\theta = 2\pi \cdot \sin\alpha - \phi$

twist angle σ to be set at $< 360°$ for the torsion of the single wire, or the differential angle:

$$\Delta\sigma = 360° - \sigma$$

IIIa.

$$\Delta\sigma = 1772\ (D/S)^2\ [1 - 7.4\ (D/S)^2 + 61\ (D/S)^4 \ldots]\ \text{[Degree]}$$

or simplified

$$\Delta\sigma \approx 1674\ (D/S)^2 + 0.17\ \text{[Degree]}$$

* * *

Condition: Torsion of single wire = 0. Backtwisting angle < than 330°.

* * *

The result is graphically represented in Fig. 3.

* * *

From this we also obtain the backtwist angle σ to be adjusted larger than 360° for the torsion of the rope, or the differential angle.

$$\Delta\sigma = \sigma - 360°$$

IIIb.

$$\Delta\sigma = 7461\ (D/S)^2\ [1 + 7.9\ (D/S)^2 + 91\ (D/S)^4 \ldots]\ \text{[Degree]}$$

or simplified

$$\Delta\sigma \approx 7867\ (D/S)^2 - 0.58\ \text{[Degree]}$$

* * *

Condition: Torsion of rope or strand = 0. Backtwisting angle > than 360°.

Fig. 3 $\Delta\phi = 360° - \phi$

$\Delta\phi = 1772\,(D/S)^2\,[1 - 7{,}4\,(D/S)^2 + 61\,(D/S)^4 \ldots\ldots]$

$\Delta\phi \approx 1674\,(D/S)^2 + 0{,}17$ [Grad]

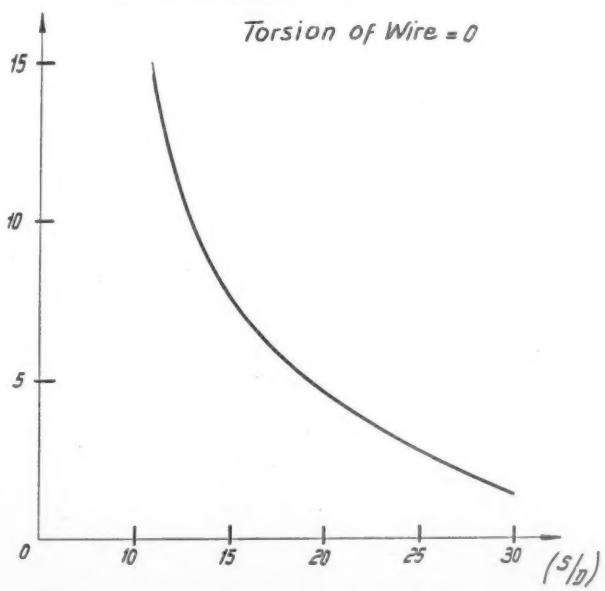
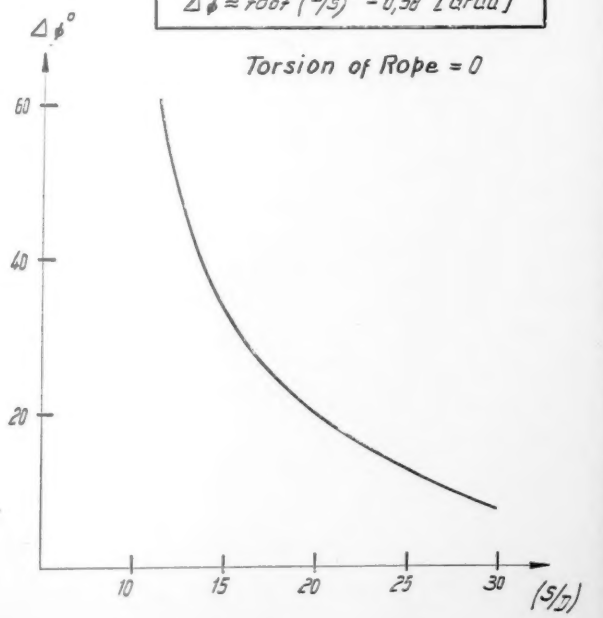


Fig. 4 $\Delta\phi = \phi - 360°$

$\Delta\phi = 7461\,(D/S)^2\,[1 + 7{,}9\,(D/S)^2 + 91\,(D/S)^4 \ldots\ldots]$

$\Delta\phi \approx 7867\,(D/S)^2 - 0{,}58$ [Grad]



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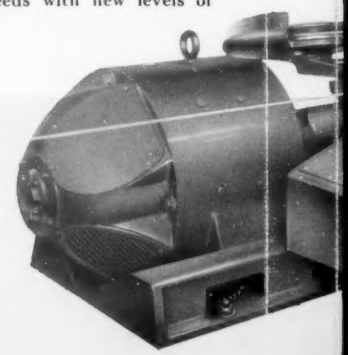

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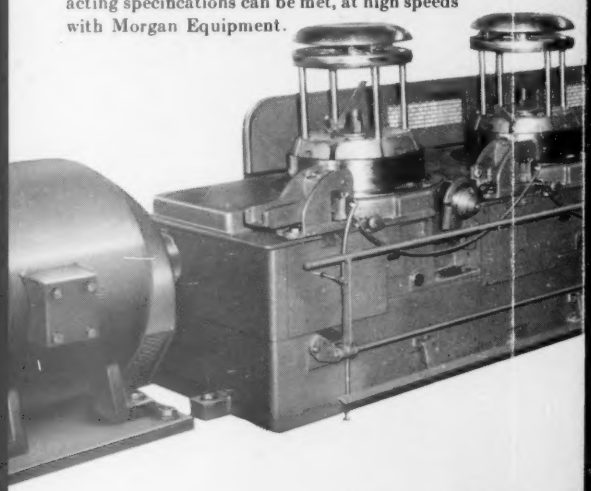

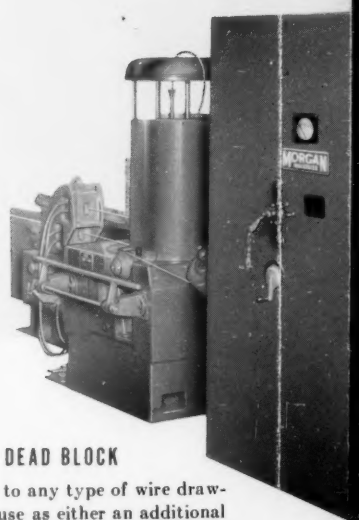

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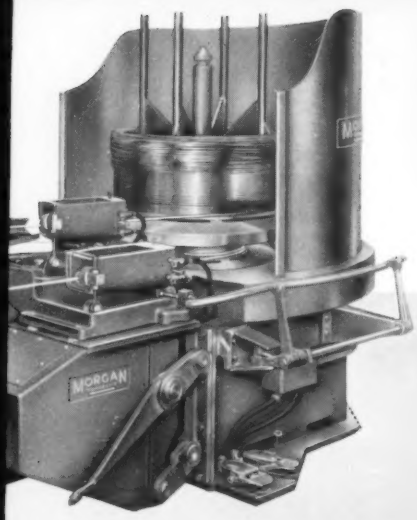
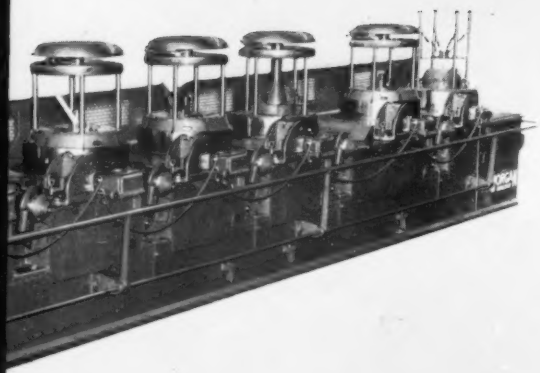


HOW MORGAN P

INTO VITAL PHASES OF W

Only at Morgan can you obtain the production-proved services which are essential for making *profitability* an engineered result—rather than a wishful objective—in any phase of your wire drawing operation.

FIRST, you have here total-concept engineering counsel which is backed by the industry's broadest mill design and erection experience. Starting at the very core of your individual production problem, Morgan engineers evaluate every contributing factor in designing an integrated installation, which precisely meets your individual requirements. Even before production line layouts are started Morgan technical studies of every phase of operations—economic feasibilty, break-even point, minimal productivity and long-term potential—supply the basic data from which decisions can be safely made.



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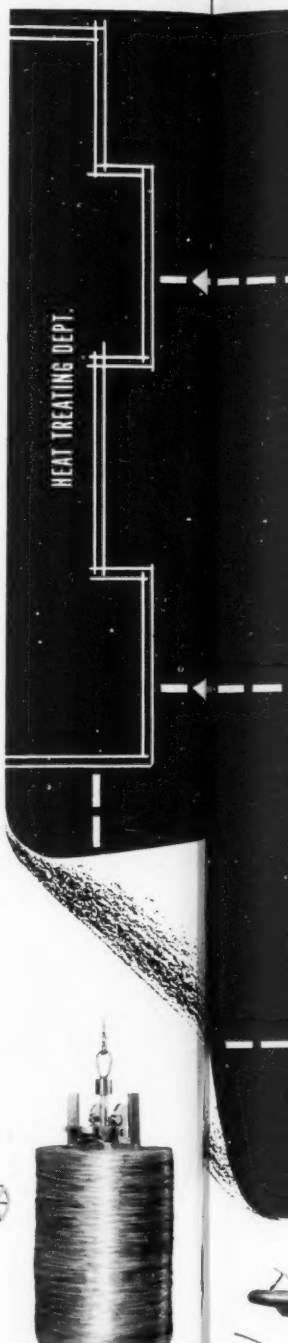

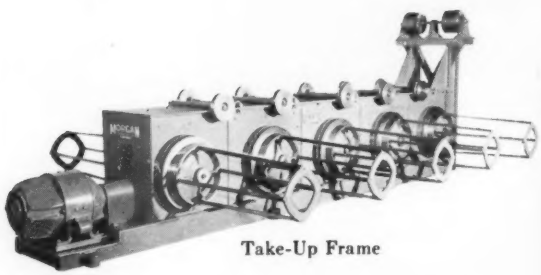

Take-Up Frame

Collapsing
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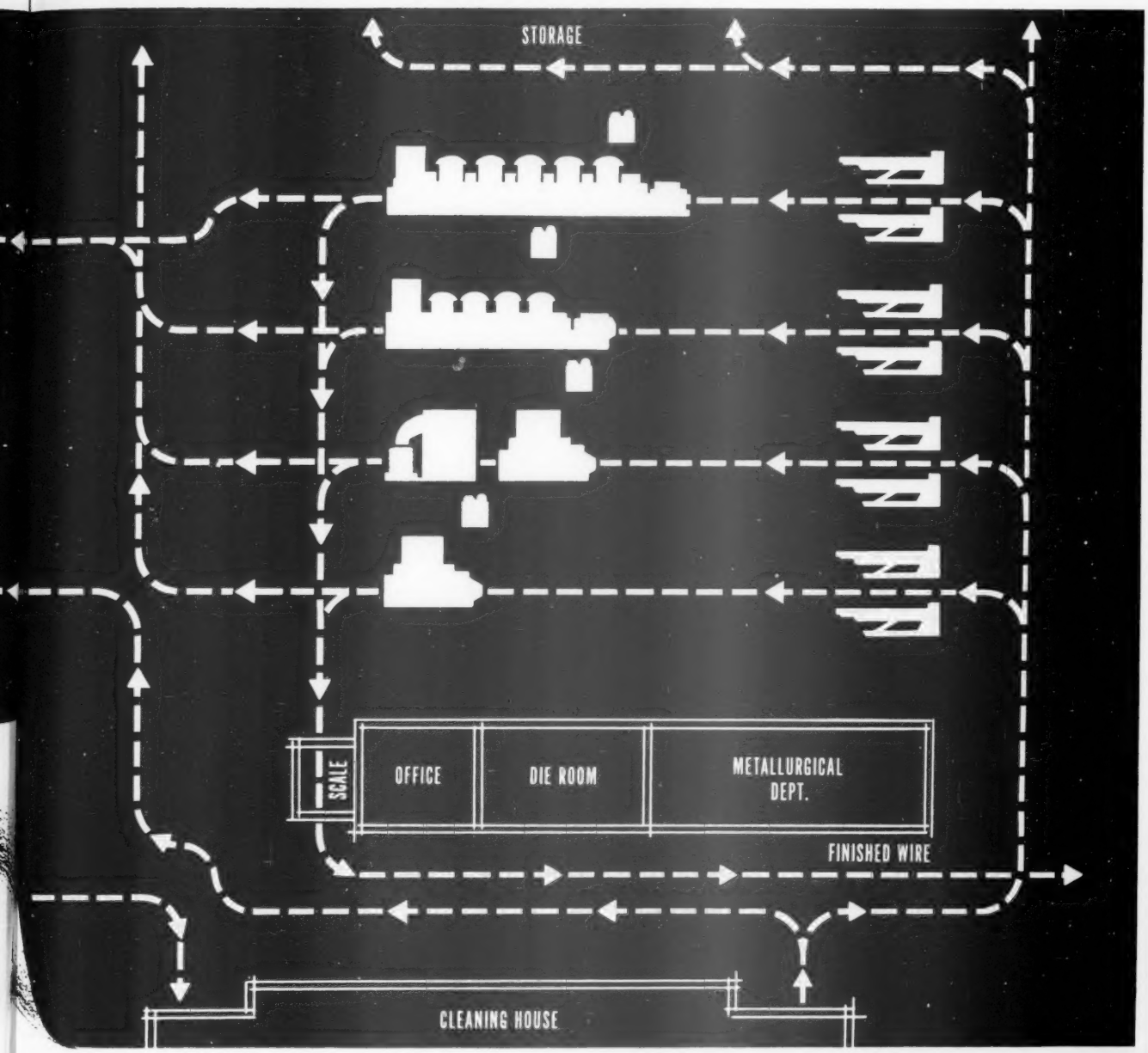
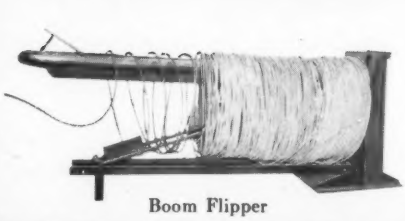
WIRE MILL OPERATION





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The result is plotted graphically in Fig. 4.

* * *

When comparing the result in the practical application of a stranding without variable backtwist, i.e., with a backturn of 360° (which primarily is used) the difference is best ascertained by means of the resulting residual moment.

* * *

I do not wish to go into the extensive derivation of the computation of the moments, which has also been based on the vector calculus of the moments and forces attacking the wire arc element, as shown in Fig. 1.

* * *

This results finally in the residual moment remaining at 360° backtwist which then tends to open or close the rope as the case may be.

IV.

$$\triangle M = -\frac{n \cdot G \cdot I\rho}{c} \cdot \frac{1 - e}{1 + e} \cdot \frac{\triangle \sigma}{2 \pi}$$

* * *

With this result it can be computed without any difficulty whether or not the application of a variable backtwist is rational or if the residual moment remaining with the usual 360° backtwist can be neglected.

* * *

As results from the above theoretical derivations and calculation formulae, two ranges of application may be distinguished in principle in the case of a torsion-free stranding with variable backtwist. Either the wire is stranded with variable backtwist so that the strand itself is practically free from torsion or the strand produced with 360° backtwist is closed to a rope with variable backtwist. The third alternative possible in theory, namely, to strand both the wire and the strand with variable backtwist, is scarcely used in practice because the resulting conditions, which cannot be controlled, are often contradictory, so that it is hardly possible to obtain a torsion-free product in that way.

* * *

What methods should be adopted for stranding is a point at issue. When considering the various opinions it may be safely said that when stranding the wire with variable backtwist we obtain a solid stable strand, which however, just because of its stability, tends to create trouble in the rope structure so as to untwist the rope. On the other hand the stable strand offers the advantage of a better power transmission so that with traction or pulling ropes subjected to high longitudinal stresses this feature is taken advantage of (for example, in cable and ropeways).

* * *

On the other hand, stranding with back-twist is preferred in cable making where freedom from torsion of the rope, the closed rope shape and a stable rope bond are required. In such cases the strand may be layed beyond the theoretically required measure of back-twist (pre-spiralled beyond 360°). The strand tends then to close the whole rope and thus to adhere closely and fastly ("crane ropes", fishery ropes).

* * *

However, instead of the variable back-twist, manufacturers often have recourse, additionally to the back-twist, to the method of preforming before stranding and postforming after stranding. In this method various devices are used for preforming, the most usual ones being distinguished by a vertical arrangement (Fig. 5) and a horizontal arrangement (Fig. 6), of the preforming rollers (or dies). Post-

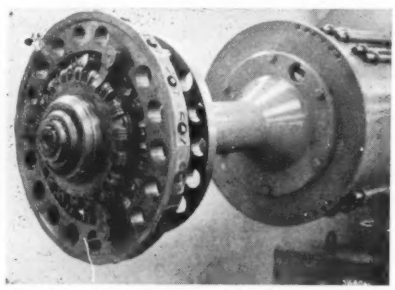

Fig. 5 * * * * * * * *

forming is ensured at least by one set, however, in a suitable set-up by a second set of dressing rolls positioned at right angles to the first set (at least 5 rolls located one behind the other) (Fig. 7).

* * *

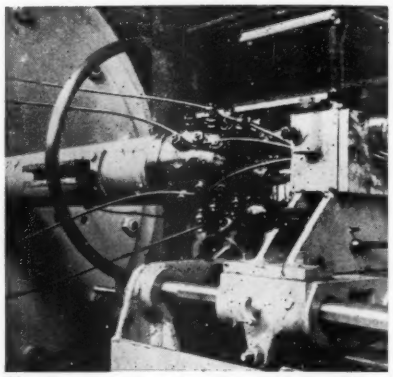

Fig. 6 * * * * * * * *

Two types of machinery are primarily used for stranding, viz., cage or planetary stranders and tube stranders. The devices used for producing the back-twist are evidently stipulated by the type of machinery used.

* * *

It so far has been quite customary to provide planetary stranders exclusively with a 360° back-twist produced by a back-turn eccentric ring positioned at the end of the cage. In this system all the cradles are connected through linking shafts (Fig. 8) to this eccentric ring. This equipment is distinguished by its simple design. However, there was a drawback insofar as all the cradles had to be connected with the back-turn ring so that hereby the structural design in particular with multi-spool machines became unrational. Both this structure and the rotary speed of the eccentric ring limited the speed of the cages.

* * *

In the further development cages were provided with a transmission located in the interior (Fig. 9). In this system the transmission shafts (mostly three) are driven from the cage support as a function of the rotation of the cage. Within the carriages the power then is distributed through the employment of a transmission (toothed wheel chains, rims and the like) to the different cradles. Thanks to such a design the adjustment of the variable backtwist has been simplified considerably, because the central element which drives the back-

(*Please turn to page* 1441)

The Swing to Aluminium for Electric Wires and Cables in India

by

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and

S. Peer Mohammed
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The Aluminium Industries Limited
Kundara, South India

V. G. G. Nayar

This paper was prepared for presentation at the Annual Convention of The Wire Association on October 23, 1961, at French Lick, Indiana.

Mr. Nayer graduated in physics in 1939 from the Madras University, and took his degree in Electrical Engineering from the Travancore University in 1943. Before joining ALIND in 1946 as its Works Manager, he has worked with some of the major cable manufacturing units in India. He has also received special training in aluminium conductor engineering with the Aluminium Limited Group of Canada.

Mr. Mohammed, a classmate and close friend of V. G. G. Nayar, graduated in Mathematics from the Madras University in 1939, and took his degree in Electrical Engineering from the Travancore University in 1943. He also holds a Master's degree in engineering from the University of Pittsburgh. While in the States he has had training with Westinghouse Electric Co., TVA, and the Buffalo Niagara Electric Corp.

Before joining ALIND as its Works Manager in 1957, Mr. Mohammed was with the Kerala State Eelctricity Board.

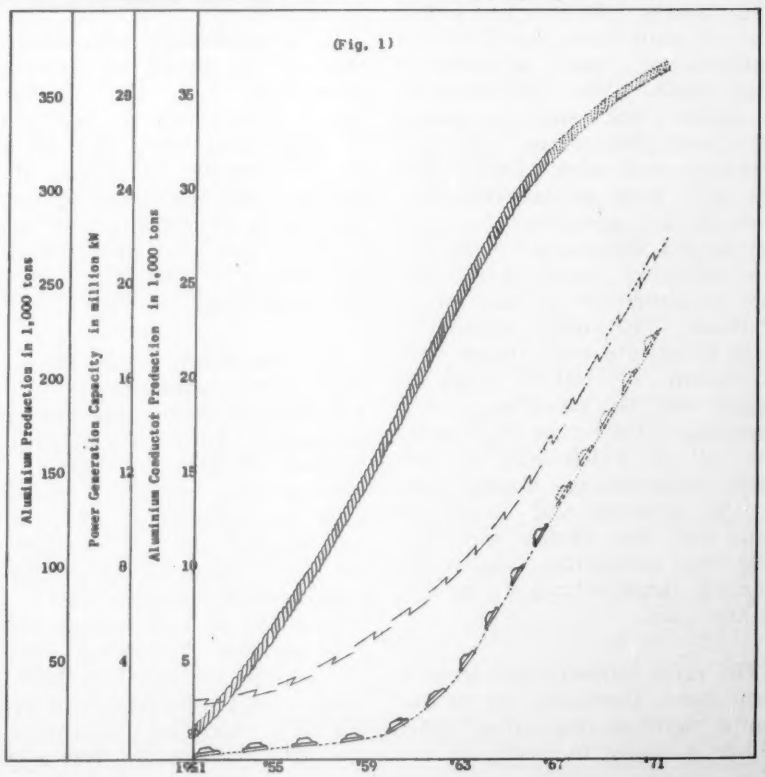
S. Peer Mohammed

The close co-existence and parallel growth of aluminium and electricity have been beautifully brought out by the Aluminium Association in a recent article[1] in Wire & Wire Products. Even more closely interlinked are the aluminium conductors and electricity industries: this is particularly true of developing countries like India where during the past few years aluminium conductor manufacture and electricity generation have emerged from next to nothingness into robust health and steady growth. The story of the aluminium conductor industry in India and its plans for the future are presented here in the hope that wire and cable industry executives and electrical engineers will find same of interest.

* * *

In India, both aluminium conductor manufacturing capacity and electricity generation have registered over twenty per cent increase every year, during the past decade. (Fig. 1) The production of aluminium in this country could not, however, keep pace with this development and even today, the bulk of aluminium metal requirements is met by imports, mainly from Canada and the U.S.A. Both government and the industry have at last realised the lacuna, and several aluminium reduction plants associating big names in the industry in the USA, Canada and Europe, are coming up all over the coun-

(Fig. 1)



(Fig. 2)

Primary Aluminium Capacity
(in long tons-per year)

	Present capacity	Addition during Third Plan	Capacity at the end of Third Plan
Aluminium Corpn. of India, W. Bengal	2,500	5,000	7,500
Indian Aluminium Co. Ltd. (Alcan)			
Alwaye	5,600	-	5,600
Hirakud	10,000	10,000.	20,000
Hindustan Aluminium Corpn., Rihand, U.P. (Kaiser Aluminum)	-	20,000	20,000
Tendulkar Industries Maharashtra (Alcoa)	-	20,000	20,000
Madras Aluminium Co. Madras (Monticatini)	-	10,000	10,000
Smelting Plant at Hubli-Dharwar area* (Reynolds)	-	30,000	30,000
Smelting Plant being set up in collab. with Technoimpex, Hungary*	-	20,000	20,000

*name of the industrial unit and exact location are yet to be fixed.

try (Fig. 2).

* * *

Thus, towards the end of the Third Five Year Plan (1966), over 125,000 tons of aluminium is expected to be available from indigenous production. For meeting the growth-rate of the electricity industry, the country will need nearly 30,000 to 40,000 tons of aluminium for overhead transmission and distribution lines alone. Over 100,000 tons of copper will still be needed per year for other electrical purposes, and most of this copper will have to be imported. Even if this quantity of copper can be got from other countries, the necessary quantum of foreign exchange is unlikely to be available. The only alternative is to substitute such usage with aluminium — 100,000 tons of copper can be substituted with less than 50,000 tons of aluminium, all of which will be produced indigenously. Copper cannot be obtained and aluminium can, and the choice obviously falls on aluminium since the planned targets have to be met in any case.

* * *

The cable industry and government have, therefore, set in motion a vigorous substitution drive which is likely to result in due course in the most thorough switch-over from copper to aluminium in the electrical industry that has been planned or executed in any country. The results so far achieved in this campaign are encouraging and impressive.

ACSR For Transmission

It is universally acknowledged that of all metals or materials, aluminium has the maximum mass conductivity for electricity — more than twice that of copper. Economy in price, light weight, high resistance to corrosion, good workability and other qualities have led to ever-widening usage of aluminium in the electrical field.

* * *

The excellent combination of steel and aluminium in ACSR (Aluminium Conductors Steel Reinforced), first developed by **William Hoopes** in 1907, integrating the strength of steel with the conductivity of aluminium, enabled the use of aluminium conductors for long-distance transmission applications. Today, ACSR is the obvious power transmission conductor choice, but copper continued to hold its sway even in this field[2], in India, till 1926 when the first transmission line using ACSR was strung between Kanakampalli and Sarajpur in Mysore State. Since 1950, when ACSR manufacture was first established in India, all transmission lines in this country have invariably been using ACSR. Special type ACSR using No-Ox-Id and other type of grease protection on the steel core have been developed and used in saline areas and similar corrosive locations. Special conductors with specially engineered combinations of aluminium and steel strands[3] have been developed for river crossings involving long-span constructions, and several such installations covering spans up to and over 5,000 ft. have already been strung. Nearly 500,000 miles of ACSR are already in the air, energised at voltages ranging from the lowest tension (230 V) to extra high voltages (230 kV).

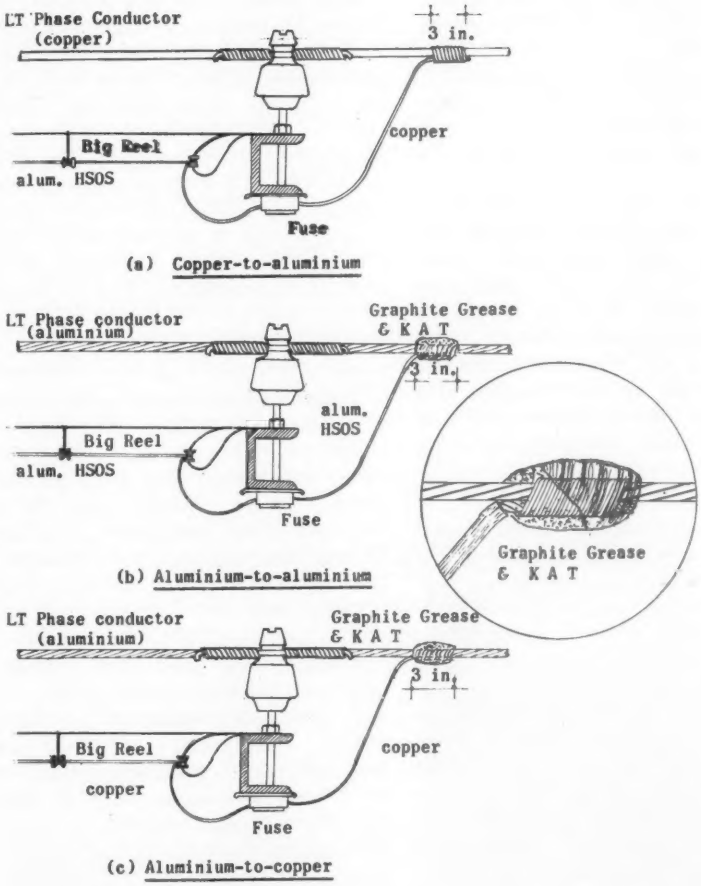
AAC For Distribution

The M-12 order issued by the National Production Authority in the USA in November 1950, limited the consumption of copper for non-essential uses and more or less compelled all electrical undertakings to turn to aluminium for their LT distribution lines. Similar conditions forced electrical engineers in India to change over to all-alumnium conductors (AAC) for distribution purposes in 1951 when copper, and to a lesser extent aluminium, became scarce in the wake of the Korean War. Several hundred thousands of miles of distribution lines with AAC have been strung since. Original and ingenious line construction methods (Fig. 3) have been devised by the electrical utility engineers in this country for ensuring economy with efficiency. Special mention must be made of methods developed for taking tap-offs for house services using copper-cored service wire and for bimetallic connections between aluminium and copper distribution systems[6].

* * *

Most of the state electricity boards and utilities of the Indian Union have by now completely taken to AAC for this applica-

(Fig. 3)



tion. An idea of the dimensions of the demand at present and for the future for AAC can be had from the fact that it is planned to progressively take electricity to all the 600,000 villages in this country. In a vast and ambitious programme of rural electrification during the next five years alone, it is proposed to cover 20,000 to 25,000 villages. All concerned are convinced of the sound economics behind the use of AAC for rural distribution. The Madras State Electricity Board, who have achieved spectacular results in this field, have calculated[7] that lines using all-aluminium conductors are about twenty-four per cent cheaper than lines using copper (Fig. 4).

* * *

Another promising application of both ACSR and AAC is for substation bus-bars, and several substations in this country are now being built using ACSR or stranded aluminium wires, instead of copper bus-bar sections.

Aluminium For Overhead Telecommunication Lines

Considerable experimental work has already been carried out in the use of aluminium conductors for overhead communication circuits by the Indian Posts & Telegraphs department. A 24-mile experimental line using ACSR[8] was installed in Central India some years back, and has been under observation ever since. It is learnt, the performance of this line has been satisfactory.

* * *

The Posts & Telegraphs department are being persuaded[9] to switch over to ACSR for overhead telecommunication lines and save on costs.

* * *

Most of the major electricity systems are installing private telephone lines using small size ACSR. Considerable interest has also been shown in the possibility of switching over to aluminium in the railway systems of the country for electric traction and signalling.

* * *

(Fig. 4)

	copper conductor £	equivalent aluminium £	savings £	percentage savings %
Cost per mile of line with phase conductor No. 4 and neutral No.6 (250 ft.)	10,000	6,850	3,150	31.02
Phase conductor No.6 and neutral No. 8 (250 ft.)	7,800	5,850	1,950	25.00
Phase conductor and neutral - all No. 8 (250 ft.)	6,400	4,850	1,550	24.20

(Fig. 5)

Comparison of aluminium and copper conductors

	aluminium : copper
for equal resistance	
Area ratio	1.61 : 1
Diameter ratio (round conductors)	1.27 : 1
Weight ratio	0.48 : 1
for equal current and temperature rise	
Area ratio	1.39 : 1
Diameter ratio	1.18 : 1
Weight ratio	0.42 : 1
for equal diameter	
Resistance ratio	1.61 : 1
Current carrying capacity	0.78 : 1

Not the least important of the factors that are influencing governmental authorities to turn to aluminium from copper is the trend towards the increasing number of copper wire thefts with consequent dislocation of service and other inconvenience.

The 'C A C' Story

Large-scale peace-time application of aluminium in covered conductors was stimulated in the USA in 1947 due to the more plentiful supply of the light metal. The National Electrical Code was amended to permit the use of covered aluminium conductors (CAC) and the Underwriters' Laboratories were quick to set their seal of approval on this new application.

* * *

The bulk of an aluminium conductor is normally greater[10] than that of the equivalent copper conductor. The difference, however, is dependent on whether the voltage drop or temperature-rise is adopted as the criterion for a given application. When temperature-rise is the determining factor, the current-rating for aluminium conductor cables is 0.78 that of the same size copper cable up to 0.4 sq. in. cross-section. For larger sizes this rating is increased up to 0.83, in a 1.0 sq. in. conductor of multi-core cable. Fig. 5 indicates the important ratios of the two metals.

C A C In India

In 1957, when CAC was made in the country for the first time, the very first item to be put on the market was HSOS wire for service-drops. This was a natural sequence to the large-scale adoption of aluminium for distribution lines. This new link in distribution effectively cut out electrolytic corrosion at the tap-off points.

* * *

Indian specifications are influenced to a very large extent by British practices and the first aluminium-cored service-drop cable that was put in the market perforce had to conform to the conventional weatherproof wires with rubber insulation, proof-taping, cotton-braiding and compounding. The aluminium-cored cable introduced under the trade-name "Alind All-Weather", thus, incorporated aluminium conductor wires to BS 2791:1956, polythene insulation to BS 1557:1954 and taping, cotton-braiding and weatherproof compounding to BS 7:1953.

* * *

Alind All-Weather proved extremely popular and even in the first year, electrical engineers in the country took to it readily and sympathetically. Today, most of the state electricity boards and private electric supply undertakings have approved this versatile and economical wire for HSOS applications[11].

* * *

The next item to be developed was a suitable aluminium-cored building wire. The standard and most popular type of indoor wiring adopted in this country incorporates rubber-insulated tough rubber-sheathed cable (commonly known as CTS) clipped on to teakwood batten. Alind Ker-Al-Lite building wire (made to BS 2791:1956 for aluminium conductor wires and BS 1557:1954 for polythene insulation and pvc sheathing) which was the trade-name of the type of wires offered for this application was well received (Fig. 6) because of its lightness and its other characteristics.

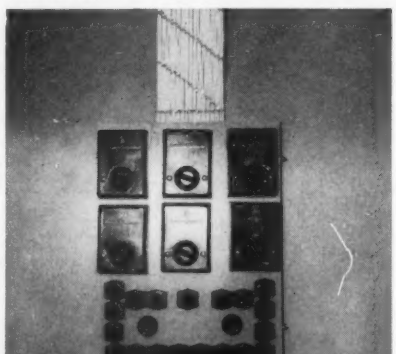


Fig. 6—A typical installation employing ALIND KER-AL-LITE Building wire in the place of CTS wires. * * * * *

Several major buildings and factories have been wired successfully with these wires and all these installations are giving trouble-free and satisfactory service.

* * *

A cheaper substitute had to be found to compete with ordinary VIR insulated copper wires for use in teakwood capping-and-casing or in conduit-wiring. The special pvc insulated, low-cost, all-purpose wire (made to BS 2791:1956 for aluminium conductors and BS 2004:1955 for pvc insulation, and marketed under the trade name: Alind Al-Vinyl) was, therefore, developed and offered as an ideal alternative to VIR insulated copper wires.

* * *

Welding cables and multi-core workshop flexibles with polythene/pvc insulation and pvc sheathing have also been developed, using 0.012 in. wire for individual conductor strands. These are lighter and cheaper, and are bound to obtain wide acceptance.

* * *

During the past four years, electrical utility engineers in India have had occasion to fully satisfy themselves about the weatherproof characteristics of polythene insulation and it has, therefore, been possible to market plain black polythene insulated aluminium wires conforming to ASTM Designation D-1359-54T for out-door weatherproof installations. In due course, it is proposed to promote the usage of multiplex wires with single, two or three insulated aluminium wires stranded with a bare all-aluminium conductor or ACSR which will be used as the guy-wire (similar to the duplex, triplex and quadruplex for service connections now so popular in the USA).

* * *

Some of the provisions of the Indian Electricity Rules do not, at present, permit large-scale usage of these wires: however, this difficulty is expected to be solved in the foreseeable future by initiating suitable amendments.

* * *

Polythene, like aluminium, is very light, and is an effective in-

sulant with much higher dielectric strength than pvc. Again, like aluminium, polythene can be produced from basic raw materials which are in plentiful supply in this country. Thus, aluminium and polythene form an ideal, effective and economic combination for CAC and use of polythene insulated aluminium conductors is bound to go up in India as in the rest of the world in the years to come.

Special Installation Practices With C A C

Even at the outset, the manufacturers of CAC in India were alive to the properties of aluminium as different from copper, which call for special intallation practices. The oxide layer on aluminium conductors inhibits corrosion, but sometimes creates difficulties in making a proper connection. Along with coils of CAC, therefore, special graphite-based, high melting point grease in collapsible tubes is supplied for application at the terminals at the time of connecting the wires to the standard accessories (Fig. 7) now available. This grease

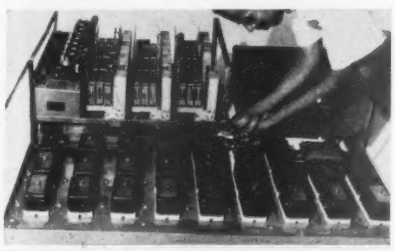


Fig. 7 — A 25-line private automatic telephone exchange, completely wired with ALIND C A C. Ker-al-lite conducting grease is being applied to circuit terminals. * * * * *

breaks through the aluminium oxide on the one hand, and prevents ingress of moisture to the bimetallic joint on the other, thus making a corrosion-proof connection. The grub screws of the switches and accessories are blunt-ended so as to avoid nicking of aluminium wires. Tinned terminals and contacts are to be preferred. All fittings and accessories used for the normal copper-cored cables could be used straight-away for CAC even though the latter are one size bigger. The normal ranges of sizes of wires for building cables can be connected to starter or motor terminals by looping the end to an 'eye' in the same manner as for copper cables and using a flat, tinned washer and with liberal application of the special grease. For sizes above 7/.044 in., lugs are recommended for making connections to motor or transformer terminals.

* * *

Standard lead/zinc/tin type solders are available for soldering aluminium and these are very effective when used with 'Kynal' flux supplied by the Imperial Chemical Industries Ltd. (Fig. 8). Compression type connectors and lugs are not yet in vogue in this country, but in due course, this will be introduced and standardised upon for bigger sizes of cables.

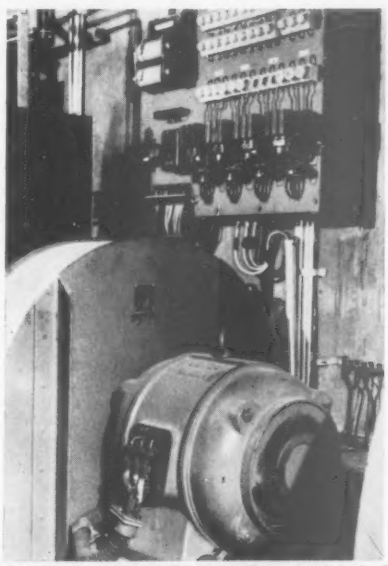


Fig. 8 (a) — Soldered connections to terminal block of a motor, using C A C. * * *

Several engineering units and textile mills have connected their industrial load applying the above technique and these installations continue to give trouble-free and satisfactory service (Fig. 9).

* * *

To ensure satisfactory connections at the tap-off points on service connections (aluminium-to-aluminium or aluminium-to-copper), a special type anti-corrosive, adhesive cotton tape, coated with water-repellent chemicals (trade named: Ker-Al-Lite

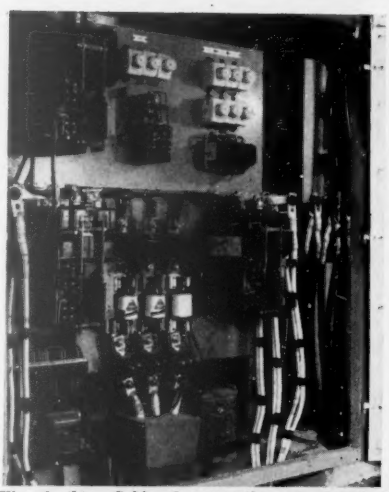


Fig. 8 (b) — Soldered connections to terminal switches. * * * * * * * *

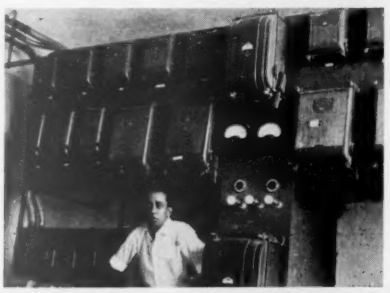


Fig. 9 (a) — Hangar and workshops of the Air India International, Bombay, represent one of the several major installations where ALIND C A C is giving satisfactory service on power and light wiring jobs. Installation practices given at pages 9a/10 have proved successful in these cases. * * * * * * *

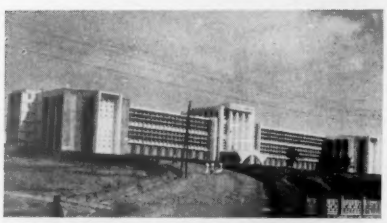


Fig. 9 (b) — College of Engineering, Trivandrum, wired exclusively with ALIND KER-AL-LITE. * * * * * * *

Anti-corrosive Tape, or, 'K A T' for short' was developed. Absolutely waterproof, quickly and easily applied, K A T ensures practically a permanent protection against atmospheric, chemical and electrolytic corrosion, and can be used with advantage on aluminium-to-aluminium or aluminium-to-copper connections, and for service connections from distribution mains.

* * *

(*Please turn to page* 1435)

DON'T LEAVE DIE REFINISHING IN THE HANDS OF CHANCE

Many plants still handle refinishing of valuable carbide dies with dry diamond individually mixed in the die room. Pre-mixed diamond compound—from all points of view—is proved superior. Elgin diamond compound—Dymo-C—is compounded to rigid standards. Diamond particles are exactly graded, thoroughly wetted and permanently suspended in the vehicle. It won't settle or concentrate.

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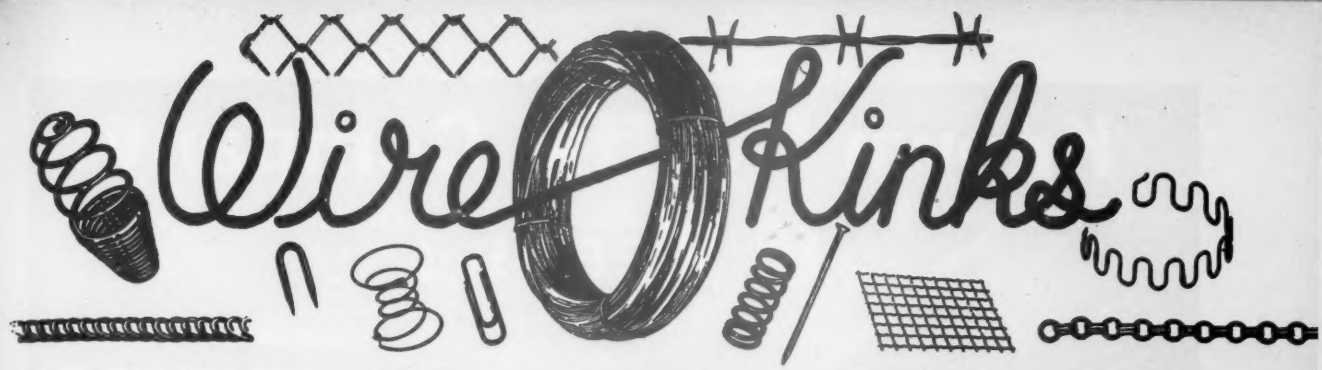

Readers are invited to send us how-to-do-it items for this department. For each item received that is published we will pay contributors $10.00. Your co-operation will be appreciated by us and our many readers. May we hear from you?

Die Cutting and Finishing

QUESTION

What are suitable materials for refinishing carbide dies and what procedures should be followed?

ANSWER

In the manufacture of new wire drawing dies or of recutting and refinishing worn dies for further drawing, the operations essentially are the same. The die is the heart of a drawing machine and its proper cutting and finishing largely determine the efficiency and accuracy of the machine's output.

* * *

Most die manufacturers and die rooms use various grades of boron carbide abrasive, depending on the work to be done on the die.

* * *

For ripping dies, sizes of 220 to 240 mesh usually are recommended. Size 320F is popular for producing semi-finish, while for final finishes, sizes of 400, 500 and 600 mesh may be used. This will leave a dull gray finish for that is suitable for many drawing operations where the wire finish is not as important as size reduction. For fine, bright wire surface finishes, it is customary to polish the die surfaces with a fine grade of diamond powder.

* * *

The abrasives are mixed with a medium to form a lapping compound that can be applied with a brush or stick. While many formulas are used for the mixture, several oils have proven successful. Some of these are olive oil, kerosene or mineral oil diluted with kerosene, as a vehicle to keep the abrasive in suspension. A mixture of half cocoanut oil and cottonseed oil has been used successfully. A soluble cutting oil of two parts of oil, one of water and one of abrasive works well.

* * *

Except for diamond powder, boron carbide is the hardest commercially available abrasive. Diamond powder, of course, must be used for all cutting or polishing operations on diamond dies.

* * *

It may not be amiss to mention that some carbide die experts feel that too high a polish on the carbide die surface reduces the efficiency of the die, especially if it has been given a highest possible polish by literally smearing the cobalt over the die surface. A somewhat lesser degree of polish is considered to pick up and hold more of the drawing lubricant and therefore do a better drawing job.

* * *

Some experimentation in finishes in the die room will lead to the best results for the drawing needs of a particular mill.

Magnet Wire Surfaces

QUESTION

We have the problem in the making of magnet wire windings of having the wires so smooth that they will not wind evenly. Is there any way to overcome this?

ANSWER

Different winding conditions require different degrees of smoothness in the surface of magnet wire coatings.

* * *

For some purposes a smooth slippery surface is desirable, especially in close progressive windings where overlapping must be avoided. For such applications some wires are even lubricated after the wire has been enameled.

* * *

For other applications, such as you may have, a higher co-efficient of friction is essential to avoid slippage or loosening of the wire on the spool or reel. This would be the case in winding coils of universal wound products, such as convergence, choke, TV peaking or fly-back coils used in electronic equipment.

* * *

In such applications an isocyanate solderable enamel is advantageous because it has a degree of roughness that provides non-slip characteristics, yet has thermal and mechanical properties equivalent to polyurethane base enamels.

* * *

Methods of test have been developed to determine the degree of friction in enamel coating surfaces. In such equipment the tension developed by the resistance of the enamel's friction properties can be measured and the gripping power of the enamel evalued.

* * *

Your problem is one on which major suppliers of magnet wire coatings should be able to render more specific advice.

Nail Making

QUESTION

We are thinking of adding a

Known By The Company It Keeps !

FLORIDA WIRE PRODUCTS
UNION WIRE ROPE CO.
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U. S. STEEL CO.
SHEFFIELD STEEL CO.
WESTERN WIRE & STEEL CO.

LOOK !! NO HANDS

Photo shows **WHITACRE-DRM-16-DC** paying off into a fibre drum. This view shows the versatility of the WHITACRE Dead Blocks. In this instance the WHITACRE is adapted to a 9-11 of continuous pass—wet drawing machine.

Of particular interest in this application is the fact that the accumulator or finishing block on the drawing machine is 8" in diameter and the finishing block on the Dead Block is 16" in diameter. The finish draft on the Dead Block is also wet. However, it can be dry, if desired.

We have applications of copper coated steel wire being drawn to 22 ga. on a 16" finishing block paying-off into fibre drums.

For further information —contact us at the Wire Convention. Arrangements to see installations can be made. With direct — personalized — plane flight from French-Lick to Chicago.

Wire **MACHINERY Inc.**

5407 S. Knox Ave., Chicago 32, Ill. POrtsmouth 7-2508

Wire Kinks

line of nails to our wire products and would like to learn from you something of their history and the points to bear in mind in making them.

ANSWER

The first nails appear to have been used in the Bronze Age and probably were copper. Nail making had been a hand process and only occasional use of them was made for centuries, wooden pegs and lashings being the principal method of fastening wood.

* * *

The first machine for the manufacture of nails was made about 1810, but even for the nails produced the heads had to be formed by hand. Shortly after the middle of the 19th century nail machines that cut, pointed and headed the nails revolutionized the industry, and the then current procedure of hammering out and heading nails by hand from slit sheet stock all but disappeared for commercial uses. This paralleled the development of the manufacture of steel wire.

* * *

A further revolution in the industry occurred in the 1920's when high speed, fully automatic nail making machines made their appearance. For a time, any scrap wire, not good enough for any other purpose, was considered satisfactory for nails. This was changed and nails now are made of specification wire of a variety of metals from copper, through low carbon steel to high carbon steel. Low carbon steel nails constitute the principal bulk of output.

* * *

Nails are made in a great variety of sizes and styles, with no heads, single and double heads, plain or spirally fluted (screw) shanks and in 2000 or so sizes and types.

* * *

Modern machines are durable, fast and accurate. They are supplied by manufacturers with indications as to maximum and minimum capacities. It is important to use wire of uniform diameter, capable of being headed, and the machines should not be overloaded.

* * *

The machines, to do accurate work, must be kept well lubricated, clean and watched for signs of wear, as small misalignments due to wear or improper adjustments can result in malformed heads or points. Poor quality in wire or improperly pickled rod can play hob with the machine components in high speed machines, especially the dies, knives and heading stamps. Lack of proper surface conditions also will make galvanizing difficult.

* * *

After forming, nails are "dewhiskered" and sterilized for use by carpenters and other consumers. Large producers so treat their nails in huge cleaners that also weigh and package the nails in cartons or kegs, all in one continuous series of operations, but production volume does not always justify this equipment and smaller units to fit anticipated output is available.

Controlling Viscosity of Wire Enamels

QUESTION

Is there any better way of maintaining the viscosity of the varnishes and coatings used in wire enameling than the constant manual checking and adding of solvents to keep the coating material from becoming too viscous?

ANSWER

A number of automatic viscosity control devices have been developed that do this work without the constant checking needed when an enameling machine operator has to do the work.

* * *

These controls function by having a series of four tanks, one containing the enamel, one the solvent, one for the mixture of enamel and solvent, and a fourth elevated tank from which the diluted mixture is fed by gravity to the enameling machines.

* * *

The viscometer device checks the dilute enamel at frequent intervals, drawing upon the supply of enamel or solvent automatically, if one or the other is required to bring the mixture to the proper degree of viscosity. The viscometer is able to maintain an accuracy of $\pm$ 1 percent in the mixture.

* * *

From the main mixing tank the enamel is pumped to the machine supply tank as required to keep it at operating levels. The viscometer can be adjusted to the needs of different types of enamels, as most coating materials have varying degrees of viscosity for correct application.

* * *

Such equipment, now widely used, eliminates the possible errors of human judgment or neglect and assures wire coatings of uniform quality.

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The Wire Association is a non-profit organization of wire mill executives, superintendents and foremen. It also includes plant engineers, traffic men, and all others engaged in the production of cold drawn bars, rods, wire, strip, insulated wire and cable, and the manufacture and fabrication of finished wire products, including cold headed, extruded and other cold worked metal products.

There are separate divisions for all the various major interests in the wire industry, steel, iron, brass, copper, alloy, and precious metals, together with divisions relating to drawing, cold working, cold heading, extruding, fabricating, forming, spring making, wire cloth, wire rope, bare and covered electric wire and cable and all other forms of wire and wire products.

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The Association functions along the following lines:

1. The use of the Association headquarters as a central clearing house for information and data of all kinds which may be of interest to members.
2. The exchange of ideas on processes of production including machinery, technical processes, etc.
3. The establishment and maintenance of friendly relations among the members of the association and the development of sectional and national meetings to discuss matters of mutual interest.
4. Studies of production methods and analysis of production costs.
5. Developments in the use of new materials and new applications of existing materials and by-products.
6. Research and collection of information on personnel management, including such factors as labor turnover, seasonal changes in the demand for employees, wage scales, etc.
7. Production simplification as a means for the effective elimination of waste.
8. Such other subjects as may be determined upon.

Greetings:

On behalf of the Officers and Directors of The Wire Association, I am happy to extend greetings to you who have come to French Lick Springs to participate in our history-making Thirty-Second Annual Convention.

I say "history-making" because this year we have departed from our established practice of holding this meeting in a large city and having plant inspection tours a part of the scheduled activities.

Our program, of necessity, has undergone many modifications. It is hoped they will make this year's convention highly enjoyable, as well as richly rewarding from a practical standpoint. Among the innovations are two open afternoons that will make it possible for our members and guests to enjoy the resort's fine recreational facilities.

May I welcome all wire men to the 1961 Annual Convention and express the hope that you will register your reactions to our "noble experiment" with any of the officers or directors for their future guidance.

Our program has been arranged under the direction of General Program Chairman, John L. Sanderson, and I trust that it meets with your approval.

It will be my pleasure to see and greet you personally at French Lick.

RAYMOND S. WORTH

R. S. Worth

President
THE WIRE ASSOCIATION

THE ANNUAL CONVENTION OF THE WIRE ASSOCIATION

FRENCH LICK-SHERATON HOTEL, FRENCH LICK, INDIANA

OCTOBER 23 to 26, 1961

The Wire Association's Headquarters in the Hotel will be open
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YOU ARE CORDIALLY INVITED TO CALL AND MEET OTHER WIRE INDUSTRY MEN

REGISTRATION FEES: MEMBERS — $15.00; GUESTS — $18.00; LADIES — $5.00. CHARGES FOR MEALS WILL BE INCLUDED IN THE HOTEL'S AMERICAN PLAN BILL. SHOW YOUR MEMBERSHIP CARD WHEN REGISTERING AND WEAR THE BADGE YOU WILL RECEIVE THROUGHOUT THE CONVENTION.

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Harold L. Schilling
Prod. Eng. & Devel. Supvr.
Kaiser Aluminum & Chemical Corp.
Newark, Ohio

Carl L. Sherman, Met.
Phillips Electrical Co. Ltd.
Brockville, Ont., Canada

Roger J. Schoerner, Vice Pres.
Southwire Corp.
Carrollton, Ga.

Benoit J. Sirois
Director of Research
Phelps Dodge Copper Products Corp.
Elizabeth, N. J.

Simultaneous Technical sessions will be held for each section or division. See program on following pages. All wire men are welcome to come to the convention and attend the sessions.

Technical papers will be preprinted in the October issue of Wire and Wire Products insofar as possible. Titles to papers accepted become the property of The Wire Association and are duly copyrighted at the time of publication. All papers presented by members are eligible for consideration for the Medal Awards and other awards made each year for outstanding excellence.

THE ANNUAL CONVENTION of
THE WIRE ASSOCIATION

October 23 to 26, 1961, French Lick-Sheraton Hotel, French Lick, Ind.

It is suggested that all persons attending this Convention plan to arrive on Sunday, October 22, to register and attend the opening function on Sunday evening.

THE PROGRAM

Oct. 22, 2:00 P.M. — Registration
8:00 P.M. — The President's Reception. Informal.

Oct. 23, 10:00 A.M. — Meeting of the Board of Directors
12:30 P.M. — Directors' Luncheon to Program Participants
2:00 P.M. — Joint Opening Session
Address of Welcome — Raymond S. Worth, President
Presentation of 25-Year Certificates to Members.
The Mordica Memorial Lecture: "How Soviet Wire Mills Compare with Those of the Rest of the World", by David M. Schmid, Pres., Techalloy Company, Rahns, Pa.

TECHNICAL SESSION

MODERATOR

John H. Corson, Mgr., Webb Wire Div., The Carpenter Steel Co., North Brunswick, N. J.

PAPER: "Continuous Conveyorized Loop Processing — A New Concept of Rod and Wire Handling" — by John Zouck, Gen. Mgr., Wirecrafters, Inc., Towson, Md.

PAPER: "The Swing to Aluminium for Electric Wires and Cables in India", by V. G. G. Nayar, Gen. Mgr., and S. Peer Mohammed, The Aluminum Industries Ltd., Kundara, India.

4:30 P.M. — Annual Meeting of Members of The Wire Association

FERROUS TECHNICAL SESSION

October 24, 9:00 A.M.

MODERATOR

Carleton W. Garrett, Met. Eng., Jones & Laughlin Steel Corp., Pittsburgh, Pa.

PAPER: "Effect of Drafting on Residual Surface Films in Wire Drawing" by Stanley L. Stalson, Res. Proj. Eng., American Steel & Wire Div., United States Steel Corp., Cleveland, Ohio.

PAPER: "The Processing of Steel into Cold Heading Wire", by Robert W. Davis, Supt., Bolt and Forged Products, Sheffield Div., Armco Steel Corp., Kansas City, Mo.

PAPER: "Controlling Quality of the Surface of Wire by Nondestructive Tests" by Henry G. Bogart, Branch Mgr., Magnaflux Corp., New York, N. Y.

PAPER: "Surface Defect Detection" by Harry F. Ammarell, Plt. Met. — Cold Drawing, and Richard B. Moyer, Nondestructive Testing Eng., The Carpenter Steel Co., Reading, Pa.

October 25, 9:00 A.M.

MODERATOR

Fred A. Webber, Chief Met., Wickwire Spencer Steel Div. of The Colorado Fuel & Iron Corp., Buffalo, N. Y.

PAPER: "A New Approach to Die Shop Operations" by D. K. White, John A. Roebling's Sons Div., The Colorado Fuel & Iron Corp., Trenton, N. J.

PAPER: "Investigation of Variables in the Zinc Socketing of Wire Rope and Strand" by C. W. Smollinger, and J. B. Cornish, Research Engs., Bethlehem Steel Co., Bethlehem, Pa.

PAPER: "Wire Electrogalvanizing Process at the Steel Company of Canada Ltd. Dominion Works", by N. M. Switucha, Met., Metallurgical Div., The Steel Company of Canada Ltd., Montreal, Canada.

PAPER: "Oil Tempering High Carbon Spring Wire with a Nitrogen Atmosphere Hardening Furnace" by A. I. Cidonio, Industrial Chemist, The Colorado Fuel & Iron Corp., South San Francisco, Cal.

NON-FERROUS MECHANICAL WIRE TECHNICAL SESSION

October 24, 9:00 A.M.

MODERATOR

Earle W. Lovering, Met. Eng., Scovill Manufacturing Co., Waterbury, Conn.

PAPER: "The Properties of Copper — Titanium Alloys" — by William B. Steward, Jr. and James J. Powers, Jr., Research & Development Group, Frankford Arsenal, Philadelphia, Pa.

PAPER: "Rolling Flat Wire in High-Speed Multi-Stand Mills" by Frank Bares, Mgr., Mill Machinery, Machine Div., The Torrington Manufacturing Co., Torrington, Conn.

PAPER: "Progress Report on the New Model 7 Properzi Equipment for the Continuous Casting and Rolling of Copper, Aluminum and Zinc" — by James B. Russell, Chief Met., Nichols Wire & Aluminum Co., Davenport, Iowa.

PAPER: "Production and Characteristics of Chemically Purified Hydrogen Precipitated Copper Powder" — by Jack F. Whitaker, Pres., Whitaker Cable Corp., North Kansas City, Mo.

ELECTRIC WIRE AND CABLE TECHNICAL SESSION

October 24, 9:00 A.M.

MODERATOR

Michael M. Suba, Mgr., Extrusion Markets, Union Carbide Plastics Co., New York, N. Y.

PAPER: "Some Aspects of the Compatibility of Various Electrical Insulating Materials" by J. E. Sloat, Prod. Mgr., F. Frank Markel & Sons, Norristown, Pa.

PAPER: "Insulating Wire and Cable with Silicone Rubber" — by Donald R. Say, Silastic Fabricating Lab., Product Engineering Dept., Dow Corning Corp., Midland, Mich.

PAPER: "What's Behind Underwriters' Requests for Insulated Wire and Cable" — by H. E. Collins, Service Engineer, Approvals Laboratory, Underwriters' Laboratories, Inc., New York, N. Y.

PAPER: "Wire Coating with Polyethylene Resins: Improvement in Extrudate Quality by Using Sensitive Instrumentation" — by Dr. F. H. Skewis, Polychemicals Dept., Technical Services Laboratory, E. I. du Pont de Nemours & Co., Wilmington, Del.

COMBINED MECHANICAL WIRE AND ELECTRIC WIRE & CABLE TECHNICAL SESSION

October 25, 9:00 A.M.

MODERATOR

J. K. Gillett, Pres., Industrial Equipment Co., Englewood, N. J.

PAPER: "Semiconductive Compounds for Wire and Cable Extrusion — by A. E. Tarbox, Development Associate, Union Carbide Plastics Co., Bound Brook, N. J.

PAPER: "An Analysis of Wire Insulation by the Fluidized Bed Process" — by Henry Kumagai, Res. Eng., Western Electric Engineering Research Center, Princeton, N. J.

PAPER: "Low Stress Elongation (LSE) Testing of Copper Wire" — by Matti J. Saarivirta, Research Supervisor, AMCO Research & Development, Inc., Sub. of American Metal Climax, Inc., Carteret, N. J.

PAPER: "The Place of Polyethylene as a Wire and Cable Insulation" — by J. C. Norton, Corporation Consultant for Electrical Engineering, Union Carbide Olefins Co., South Charleston, West Va.

SCHEDULED ACTIVITIES OTHER THAN TECHNICAL SESSIONS
ANNUAL CONVENTION OF THE WIRE ASSOCIATION

SUNDAY, OCTOBER 22

8:00 P.M. — The President's Reception. Informal attire.

MONDAY, OCTOBER, 23

10:00 A.M. — Meeting of the Board of Directors.
12:30 P.M. — Directors' Luncheon for Program Participants.
4:30 P.M. — Annual Meeting of Members of The Wire Association.
6:00-7:00 P.M. — Hospitality Hour — Courtesy of Suppliers.

TUESDAY, OCTOBER 24

1:30 P.M. — Meeting of the Electric Wire & Cable Management Committee.
8:00 P.M. — Evening at the Races. Movies of 8 real races. "Betting" on the ponies (no money involved), with prizes to those who pick the most winners.

WEDNESDAY, OCTOBER 25

6:00-7:00 P.M. — Hospitality Hour on Pay-as-You-Go basis.
7:00 P.M. — The Annual Dinner. Informal attire.
Awards for outstanding 1960 papers presented to:

IN THE FERROUS DIVISION

Medal Award to GILBERT D. DILL, Consultant on Blast Cleaning and Materials Handling, Mishawaka, Ind., for his paper: "An Economic Analysis of Acid Cleaning vs. Multiple Strand Blast Cleaning of Wire Rod."

Certificate of Honorable Mention to KENNETH P. BROWN, Commodity Specialist, Pacific Metals Co., Ltd., for his paper: "The New Nickel Alloys in Wire for Special Applications."

IN THE NON-FERROUS DIVISION

Medal Award to ROBERT C. LAWRENCE, JR., Sales Representative, Chemical Products Corp., East Providence, R. I., for his paper: "Vinyl Plastisol — A Versatile Material for Insulating Wire and Encapsulating Wire Harness Constructions."

Certificate of Honorable Mention to DAVID BARR, Plant Engineer, National Electric Div., H. K. Porter Co., for his paper: "Installation of a Semi-Automated TW Wire Extrusion, Coiling and Boxing Facility in a Medium Sized Wire Plant."

After Dinner Speaker: Herbert Philbrick — American Citizen, "Communist" and Counterspy — who will talk on his experiences as an American Intelligence Agent in exposing Communist activities for the F.B.I.

On the afternoons open for recreational pursuits, Tuesday and Wednesday, golf, skeet shooting, swimming (in heated pool) and many other activities, offer opportunity for each one to indulge his favorite pastime.

LADIES ENTERTAINMENT: A special program for the ladies has been arranged. Ladies are requested to register and secure tickets and badges. They are invited to attend the Hospitality Hours, the "Races" and the Dinner. Mrs. John Sanderson will serve as Chairman of Ladies Activities, assisted by Miss Watson, Social and Recreational Director.

All meals at the hotel are included in the American Plan charges for rooms and meals, to which the hotel will add 15% to provide for gratuities. No adjustments made for meals missed or taken elsewhere than in the hotel.

MEMBERS AND GUESTS WILL RECEIVE BADGES UPON REGISTERING. PLEASE WEAR THEM THROUGHOUT THE CONVENTION FOR IDENTIFICATION.

THE MORDICA MEMORIAL LECTURE

An invitation to deliver the Mordica Memorial Lecture is considered the highest honor within the power of the Board of Directors of The Wire Association to bestow upon a member.

The lecturer is selected each year by the Board of Past Presidents on the basis of outstanding contributions to the wire industry.

The 1961 Mordica Memorial Lecture will be given by DAVID M. SCHMID, President and Treasurer of Techalloy Company, Inc., Rahns, Pa., at the opening Joint Session of The Wire Association on Monday afternoon, October 23, 1961. The title of his Lecture will be: "How Soviet Wire Mills Compare with Those of the Rest of the World."

THE ANNUAL MEDAL AWARDS

Every year a bronze Medal is presented to an author in each of the Association's divisions—Ferrous and Non-Ferrous—for those papers that come nearest to the requirements set forth herein. Honorable Mention Certificates are also awarded. These awards are presented during the Annual Convention of The Wire Association. The medals and certificates are accompanied by cash awards of $100.00 and $50.00 respectively.

* * *

Consideration for such awards is not limited to papers presented at Association meetings, but to all papers submitted by members as a contribution to The Wire Association and published in WIRE AND WIRE PRODUCTS.

* * *

All papers submitted become the property of The Wire Association and are assigned to WIRE AND WIRE PRODUCTS for copyrighting and exclusive publication.

* * *

Awards, you will note, are a recognition of a definite contribution to the advancement of the interests of the Wire Industry.

* * *

Selection of papers for awards rests in the hands of the Association's Committee on Awards, which is headed by a director of The Wire Association.

REQUIREMENTS FOR CONSIDERATION OF PAPERS

The first consideration of eligibility is that the author or authors must be Association members. A second is that it must be a contribution to the Association or to WIRE AND WIRE PRODUCTS, as articles for which the magazine has paid an honorarium cannot be considered. A third is that any paper that has been previously presented before another society or published in another magazine cannot be taken under advisement for awards.

* * *

JUDGING PAPERS

Papers eligible for awards are judged by the Oxford System, which is considered the best one so far devised for the impersonal determination of the worthwhileness of papers. Consideration is given to the following points, among others:

1. Value of the paper to The Wire Association's members as a whole.
2. Does it contain new information that has not been published hitherto, or is it merely a restatement of research material?
3. Does it constitute an advancement in knowledge by clarification of past information?
4. Does it provide a re-assessment of known facts in such manner as to be readily understood by the industry as a whole?
5. Are the claims in the paper factually supported with definite, impartial test data and established experience?
6. Is the paper valuable as a reference work?

All members of The Wire Association are cordially invited to submit technical papers either for publication in "WIRE & WIRE PRODUCTS" during the year or for presentation before the Annual Convention or the Regional Meetings.

THE TWENTY-FIVE YEAR CERTIFICATES

These certificates of The Wire Association are presented each year by the Board of Directors to those who have been members continuously for 25 years. The 1961 recipients are:

CECIL FRANK BRERETON
Chief Metallurgist
Richard Johnson & Nephew Ltd.
Bradford Iron Works
Manchester, England

PAUL E. DIMLING, Sales Eng.
American Carbide Company
Union City, N. J.

ALLAN B. DOVE
Product Development Metallurgist
Hamilton Works
Steel Company of Canada, Ltd.
Hamilton, Ont., Canada

CHARLES V. IREDELL, Manager
Lamp Division, Park Works
Westinghouse Electric Corporation
Bloomfield, N. J.

ARTHUR SLEPIAN, President
The Asco Wire & Cable Co.
Stratford, Conn.

LESTER B. SOMMER
Executive Vice President
Mid-States Steel & Wire Co.
Crawfordsville, Ind.

THE ELECTRIC WIRE & CABLE SECTION
of
THE WIRE ASSOCIATION

The committee, appointed by the Association's Board of Directors, the Electric Wire and Cable Management Committee, extends to all persons interested in and concerned with the production of insulated wire and cable a cordial invitation to join with them in promoting the progress of this branch of the wire industry. This Management Committee, as of April 26, 1961, is comprised of:

CHAIRMAN

Clement C. Lawson, Plant Facilities Eng.
Bell Telephone Laboratories, Inc.
Murray Hill, N. J.

MEMBERS

David Barr, Plant Eng.
National Electric Div.
H. K. Porter Co.
338 14th Street
Ambridge, Pa.

Grover W. Brown, Mgr.
Machinery Devel.
The Okonite Co.
Passiac, N. J.

Walter H. Dahlstrom
Chief Research Eng.
American Steel & Wire Div.
United States Steel Corp.
767 Millbury St.
Worcester, Mass.

J. J. Dowling, Pres.
Philadelphia Insulated Wire Co.
New Albany Road
Moorestown, N. J.

Charles M. Fredrickson, Technical Mgr.
Olin Conductors Metals Div., Olin
P. O. Box 989, Chattanooga, Tenn.

Alfred Garshick, Devel. Eng.
Boston Insulated Wire Co.
65 Bay St., Boston 25, Mass.

J. K. Gillett, Pres.
Industrial Equipment Co.
Box 706, Englewood, N.J.

Duncan M. Gillies, Pres.
Duncan M. Gillies Co.
66 Central St.
West Boyleston, Mass.

Elmer J. Goetz, Genl. Mgr.
Federal Wire & Cable Co., Ltd.
Div. of H. K. Porter Co.
Guelph, Ont., Canada

James S. Higgins, Plant Eng.
Copper Div.
Walker Brothers
Conshohocken, Pa.

Alexander A. Kerr, Supt., Prodn.
Reynolds Metals Co.
Chester, Pa.

C. L. Kessler, Chief Works Met.
Aluminum Company of America
P. O. Box 150, Massena, N. Y.

Urbain J. H. Malo, Technical Dir.
Narragansett Wire Co.
1102 Main St.
Pawtucket, R. I.

Glen J. Moher, Process Eng.
Canadian General Electric Co., Ltd.
107 Park St., Peterboro, Canada

W. R. Moyers, Chief Eng.
Wire Engineering Dept.
Western Electric Co.
P. O. Station B
Buffalo 7, N. Y.

Gordon C. Rollins, V.P.-Mfg.
Superior Cable Corp.
Box 35-A, Hickory, N. C.

David M. Schmid, President
Techalloy Co., Inc.
Rahns, Pa.

Benoit J. Sirois, Met. Eng.
Phelps Dodge Copper Products Co.
Bayway & Front Sts.
Elizabeth, N. J.

Michael M. Suba, Mgr. Extrusion Mkts.
Union Carbide Plastics Co.
270 Park Ave., New York 17, N. Y.

J. E. Thomas, Mgr., Brockville Div.
Phillips Electrical Co., Ltd.
Brockville, Ont., Canada

Harry E. Thompson
Consulting Cable Engineer
Anaconda Wire & Cable Co.
Hastings-on-Hudson, N. Y.

Dr. Robert C. Williams
Vice-Pres.-Research
The Ironsides Co.
270 W. Mound St., Columbus 15, Ohio

The committee arranges for papers for regional meetings and the Annual Convention, reviews them to see that they are desirable as to subject matter and quality, and formulates policies that will promote the best interests of insulated wire production personnel. Recent authorization to increase the membership to twenty-five will be implemented by further appointments in the near future.

You are invited to send for a booklet describing the activities of The Wire Association and a membership application card.

THE WIRE ASSOCIATION

RICHARD E. BROWN, Executive Secretary

453 Main St. **Stamford, Conn.**

Insulating Wire and Cable with Silicone Rubber

by Donald R. Say
Dow Corning Corporation
Midland, Michigan

This paper was prepared for presentation at the Annual Convention of The Wire Association on October 24, 1961, at French Lick, Indiana.

As silicone rubber becomes more widely accepted for wire and cable insulation more fabricators are interested in processing it. The equipment and techniques used to process organic rubber insulation can be used to process silicone rubber. However, the equipment and techniques can be modified to make the processing of silicone rubber insulation more efficient. This paper discusses briefly the properties and applications of silicone rubber. The main portion is devoted to the equipment and the processing techniques of milling, extruding, vulcanization and curing as they are related to the manufacture of insulated wire and cable.

Introduction

The purpose of this paper is to describe the equipment and techniques which are used to process silicone rubber. Included is a brief description of its properties and the application it has found in the wire and cable industry since its introduction.

* * *

For immediate purposes, the history of silicone rubber need only be traced from the year 1940. Until this time little attention had been directed to the study of high molecular weight organosilicone polymers. Work was begun at this time in the United States to utilize these unique polymers. The first products were silicone resins used for electrical insulation. By 1945 enough development work had been done with other silicone polymers to make silicone rubbers available for industrial uses.

Silicone Rubber Composition

The ingredients of a silicone rubber are similar to those of any rubber — polymer, filler, vulcanizing agent, and additives. The polymer is basically a silicon, oxygen, silicon, oxygen, etc. chain. Organic groups such as methyl, phenyl, and vinyl are attached to the silicon atoms in the chain. Each organic group or combination of groups gives the finished rubber a different set of properties.

* * *

Fillers can be divided into two groups by their ability to reinforce the polymer. A reinforcing filler produces a silicone rubber with the best tensile strength, elongation, tear resistance, moisture resistance and electrical properties. The fine synthetic silicas are reinforcing fillers.

* * *

The second group, the extending fillers, produce silicone rubber at reduced cost. Some extending fillers are ground quartz, diatomaceous earth, clay and calcium carbonate. The use of only extending fillers makes a stock of low tensile strength and elongation. By using both reinforcing and nonreinforcing fillers in combination, a balance between physical properties, lowest cost, and best handling properties can be found.

* * *

Organic peroxides such as benzoyl peroxide and dichlorobenzoyl peroxide are the most commonly used vulcanizing agents. A proper amount of peroxide is dispersed in the rubber when it is compounded. When the silicone rubber is heated above a certain temperature, the peroxide decomposes and produces vulcanization. Five different organic peroxides are used commercially to vulcanize silicone rubber. The choice of one of the five peroxides is usually determined by a number of factors. Among these are the temperature at which the vulcanization takes place, the type of vulcanizing equipment, the specific polymer used and the properties desired. There is a 100°F. vulcanizing temperature difference between the highest and lowest temperature vulcanizing agents.

* * *

Additives are used in silicone rubber for coloring or to improve heat stability.

Properties

Silastic* is used as a wire and cable insulation because it combines properties which are not all found in other insulation materials. Silastic insulated conductors will give reliable service over a range from -90°F to + 500° F. High ozone concentrations have little effect on it. Silastic also has the inherent property of nuclear radiation resistance. When exposed to open flame, it decomposes to a non-conducting silica ash with good insulating properties.

* * *

Presently silicone rubber has respectable tensile and tear strength and is resistant to many solvents and oils. By judicious selection of fillers, tensile strengths of 1500 psi are not uncommon. Recently, a research breakthrough has produced fluorosilane rubber. This compound has excellent low swell characteristics in both aliphatic and aromatic hydrocarbons and in many other organic fluids which swell general purpose silicone rubber.

* Dow Corning Trade Mark

Processing

The equipment used to process silicone rubber is the same as the equipment used to process most organic rubber insulations. In some cases, little or no modification in processing equipment needs to be done. The moditions discusesd in the following sections of this paper are ones which will give optimum efficiency in manufacture. However, one essential requirement in working with silicone rubber is a clean work area. Contamination of the stock will result in a loss of electrical and physical properties. Mills and extruders must be free from organic insulating materials to avoid this contamination.

Milling

Most silicone rubber stocks crepe harden or pseudo-vulcanize due to the reactivity between the polymer and filler. Crepe hardened stocks an be freshened on a rubber mill in much the same way organic rubber can. For ideal conditions the mill should have several accessories. It should have water cooled rolls to keep the stock being milled from reaching temperatures greater than 130°F, the temperature at which most vulcanizing agents are activated. One of the rolls should be adjustable, preferably the fast roll because silicone rubber transfers to the fast roll as milling approaches completion. For best stock working, the fast roll should operate at a peripheral speed of about 75 to 90 feet per minute. The optimum speed ration between rolls is in the range of 1.2 through 1.4 to 1. A nylon scraper blade and plows on the fast roll facilitate easier stock handling. Nylon is used because it does not give off metal wear particles that might contaminate the stock being milled. Foot operation of the scraper blade permits the operator to have freedom of both hands while working the stock (Fig. 1).

* * *

Figure 1 * * * * * * * * *

Finished stocks are available which contain additives that reduce the reactivity between the reinforcing silica filler and the polymer. Such stocks do not have to be milled for periods up to three months. However, to cut costs many fabricators have begun to compound stocks for their own use from basic gums or partially compounded gums called bases. Thus the fabricator has a choice between non-milling stocks he can buy fully compounded from the silicone rubber manufacturer

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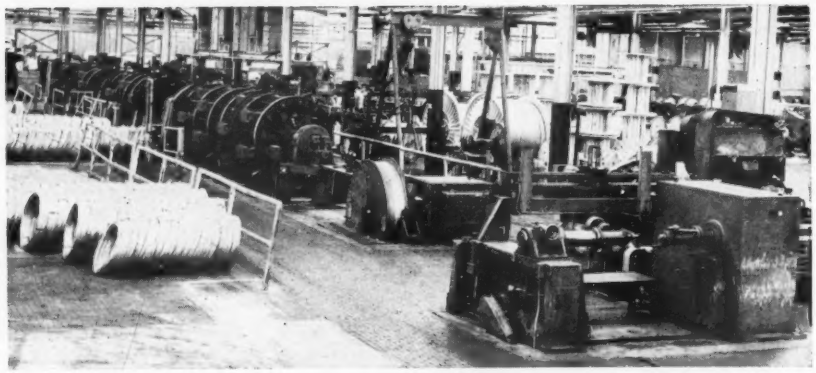

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or bases which he can use to reduce processing costs by compounding his own stocks. Once the stock is fully compounded and freshened it is ready to be processed by extrusion.

Extrusion Screws

There are several modifications in extruder design which can be incorporated to give most efficient production when extruding silicone rubber.

* * *

To obtain maximum efficiency with our silicone rubber extruders, we have tested the effect of changing several variables in basic screw design. From this work certain parameters for each variable have been established and a basic silicone rubber extrusion screw has been defined.

* * *

One variable is screw length. For two screws of similar design, a longer screw will give less variation in output per unit time. The longer of the two will also produce a higher stock output per unit time. This difference in output becomes more pronounced as the die size decreases.

* * *

A second variable to be considered is the pitch. We have found a single flight screw with a diminishing pitch toward the output end gives the least temperature buildup. A double flight screw gives more variation in output and more temperature buildup than a single flight screw. Another important variable is changing the root diameter of the screw. This affects compression ratio and output. The compression ratio depends on two variables — the screw pitch and the change in root diameter. The compression ratio has little effect on the output of silicone rubber when it is in the range from 2:1 to 3:1. The most important effect of higher compression ratio screw is to compact the silicone rubber. Decreasing the root diameter of the screw in the feed box area improves feeding. Another factor which also affects feeding is the leading edge radius of the flight. Too large a radius

in the feedbox area forces stock too high on the flight causing inefficient feeding.

Feeding

The most common method of feeding silicone rubber into an extruder is hand stuffing. A roller feed makes feeding semiautomatic. The stock is cut to a width and thickness which can be accepted by the feedbox. This strip of stock is coiled and fed directly from a hat (Fig. 2). The hat is mounted horizontally. This is

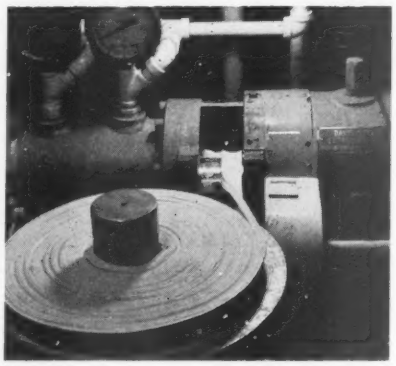


Figure 2

done to compensate for the low green strength of silicone rubber which makes the coil tend to sag when mounted vertically. We have found the best arrangement is to have the roller integrated into the feed box and rotating next to the screw in the opposite direction. The roller is driven through a clutch which can be adjusted so the roller will stop when the feed box is full.

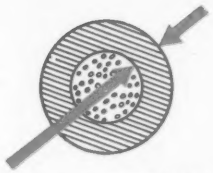
Screens

At the output end of the screw, the use of a breaker plate is recommended. This helps compact the stock and force out entrapped air. The plate should be backed with a screen pack to remove any contaminating particle which may have been picked up by the stock. Although the screen pack is a source of heat buildup, any foreign matter that is unavoidably picked up during the handling of the stock prior to fabrication is removed to give insulation of higher quality.

Dies

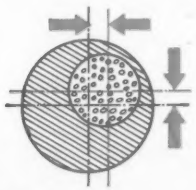
The flow characteristics of sil-

CABLEMAKERS

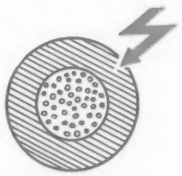


WALL THICKNESS
Monitoring or Control of Mean Wall Thickness

DIAMETER
Optical or Contact Monitoring or Control, Single or Dual Plane



ECCENTRICITY
Monitoring or Control of Coaxial and Multicore Cables and Jackets



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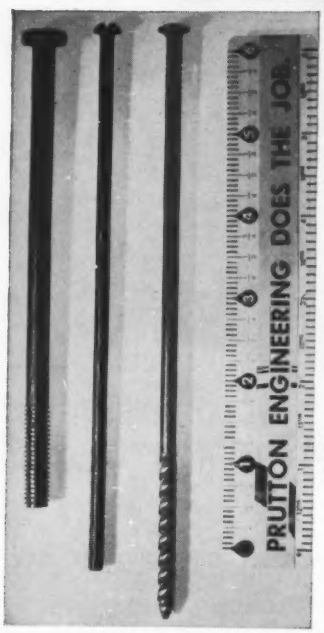
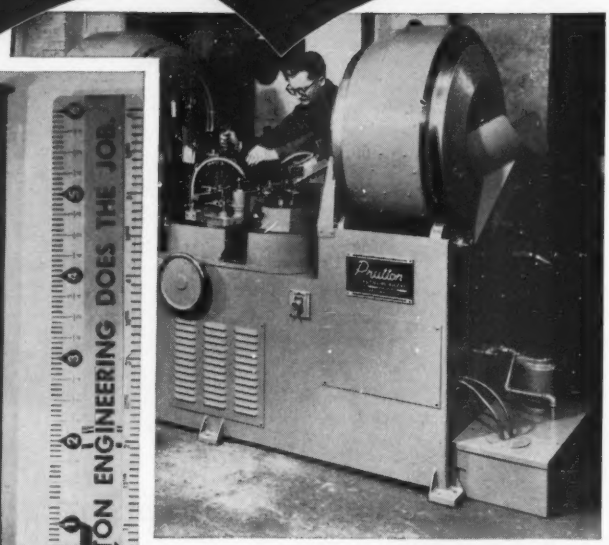
NEW Thread Rolling Machine handles 8" BLANKS at 12,000 PIECES PER HOUR!





This new Model 125A-36 PRUTTON PLANETARY THREAD ROLLING MACHINE was shipped to a Mid-Western Manufacturer to thread parts seven inches long — AUTOMATICALLY. The same machine will handle blanks EIGHT INCHES LONG and maximum diameters of 5/16". Production speed is 200 pieces per minute on the longer lengths and 400 pieces per minute on 4" lengths which are the shortest handled by the machine. Model 125A-36 is excellent for roll threading through-bolts for small Electric Motors, Gutter Spikes, Pole Barn Nails and similar long parts with threaded ends.

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icone rubber change only slightly over a wide temperature range and so the material is extruded cold. As a result, the die land length is not as critical as it is in the extrusion of many other materials. However, there are limiting considerations. If the land is too long, it will cause undue head pressure and will also tend to compact the stock only when it first enters the die. The friction will tend to ruin the compactness of the stock as it moves over the rest of the long land. When the die land is too short, the stock will tend to "breathe" or vary in diameter from improper formation at the die. A land length of the same diameter as the die opening is safe in most cases. When total O.D. of the insulated wire is in the range of 0.200" the land can become as short as one-half the diameter of the die opening and still maintain a consistent wall thickness. The dies commonly used for silicone rubber extrusion are plate or coin type dies which are common to other types of rubber extrusion. General die construction principles can be applied to silicone rubber dies. One modification is a funnel land approach. If a quantity of silicone rubber is trapped at the end of the extruder barrel over an extended period of time, it may begin to set up. This will result in restricted flow or rough extrusions. Funnel shaped land approaches are often used to direct the flow of rubber to eliminate such spots. Wire coating dies are usually within a few thousandths of actual desired insulation size.

Cooling

At high extrusion speeds the equipment may heat above 130°F, the temperature where the catalyst in the silicone rubber begins to be activated. Thus, all extrusion equipment used with siilcone rubber must be water cooled. The amount of cooling needed varies with the specific extruder and the extrusion being made with it. Some extruders have only water cooled screw jackets. Others have water cooled jackets, screws and heads.

Vulcanization

Vulcanization and curing techniques used with silicone rubber are different from those used with most other organic insulation materials. However, the equipment is the same, a steam tube (C.V.) or a hot air vulcanizer (H.A.V.) for vulcanization and an oven for post curing. Certain modifications in this equipment make processing silicone rubber easier.

* * *

During vulcanization the temperature of the rubber is raised to a point where the peroxide vulcanizing agent becomes active. As the peroxide decomposes free radicals are formed. These free radicals react with the organic groups on the silicone polymer and cross link the polymers. A standard continuous stream vulcanizer can be used with a variety of steam pressures from 150 to 250 psi to vulcanize silicone rubber. After the insulated wire is steam vulcanized and cooled it is reeled and oven dried. A standard H.A.V. operating over a temperature range 500° to 1000° F can also be used to vulcanize silicone rubber. The main body of the H.A.V. is a heated tunnel. The wire coated with raw rubber passes through this tunnel where it is vulcanized. Long H.A.V. units usually have provisions for venting volatiles produced during the vulcanization.

* * *

The H.A.V. and C.V. units each have definite advantages when used to vulcanize silicone rubber. The C. V. has high heat transfer. It is ideal for vulcanizing long runs of a large range of wire sizes at speeds from 200 to 800 feet per minute. The rate of vulcanization in an H.A.V. is slow compared to the C.V. unit. However, the H.A.V. is more flexible. It can be used economically to vulcanize specialty items, short runs and small size wire. The C.V. has the disadvantage of being hooked directly to the head of the extruder. This causes difficulty in cooling the extruder head. The C.V. is a large piece of equipment. The long steam vulcanizing tube and

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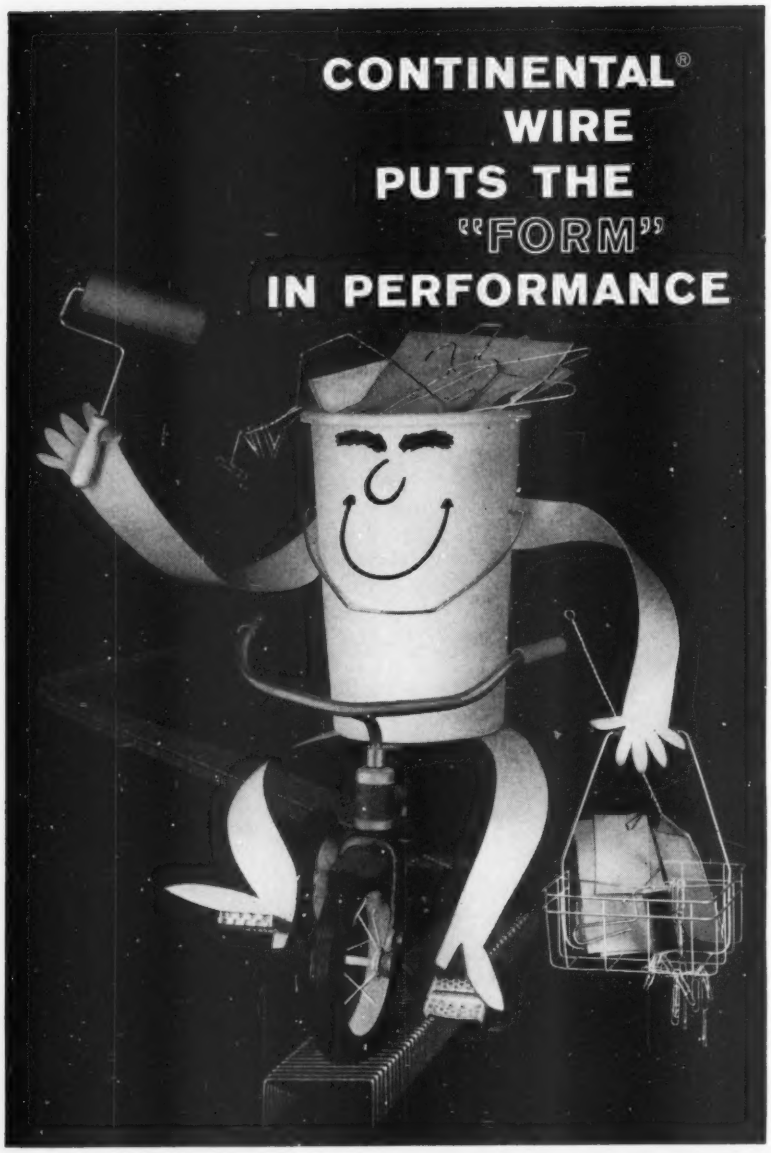

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PRODUCERS OF: Manufacturer's Wire in many sizes, tempers, and finishes, including Galvanized, KOKOTE,® Flame Sealed, Coppered, Tinned, Annealed, Liquor Finished, Bright and special shaped wire. Also Welded Wire Reinforcing and Galvanized Fabric, Nails, Continental Chain Link Fence, and other products.

the water bath require a large amount of installation room. The C.V. is expensive to install and operate, but has merit when used for long production runs. The final choice of the vulcanizing equipment depends on the production variables involved.

* * *

Silicone rubber vulcanizes from the outside until the entire cross section is vulcanized. The speed of vulcanization in an H.A.V. depends on the variables of heat transfer and wall thickness. In an H.A.V. heat transfer depends mainly on H.A.V. temperature. After initial vulcanization, the rubber can remain in the H.A.V. for a critical time with no effect on the physical properties of the insulation. This critical length of time is inversely related to the H.A.V. temperature. If the insulation is in the H.A.V. for too long a time physical and electrical properties will deteriorate. Because silicone rubber vulcanizes from the outside in, heavier wall sections will require longer times in the vulcanizer.

* * *

One modification which improves H.A.V. vulcanization is the use of circulating air to increase heat transfer. The rate of heat transfer is higher in an atmosphere of circulating air than it is under static air condtions. If the insulating jacket of static air which forms around the wire being vulcanized can be displaced, the heat transfer can be increased. This can be accomplished by air preheated in a tube in the H.A.V. tunnel. This preheated air is blown through the tunnel from a perforated section of the tube which extends along the inside of the tunnel. The circulating air results in more uniform temperature throughout the H.A.V., lower operating temperatures with equivalent vulcanization and faster vulcanization over the entire range of H.A.V. temperatures.

* * *

When using a hot air vulcanizer the size and temperature of the conductor being insulated are important factors which affect the vulcanization rate. Preheat-

ing the conductor prior to insulating it can greatly speed up the vulcanization rate. The conductor can be preheated by placing spools of wire in a hot air oven at temperatures as high as 400°F. The wire is then taken from the oven directly to the extruder. Preheating chambers in the wire train, just ahead of the extruder, produce similar results.

* * *

In the C.V., the heat transfer depends on the steam pressure and is more rapid than H.A.V. The heat transfer is rapid enough that "flash vulcanization" occurs in about 5 seconds in small wall sizes. Figures 3 and 4* show that while the critical

EFFECT OF VULCANIZATION TIME AND H.A.V. TEMPERATURE ON TENSILE STRENGTH

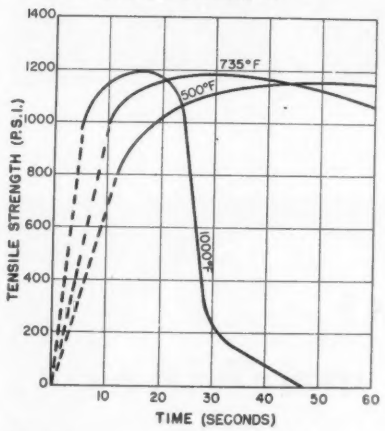


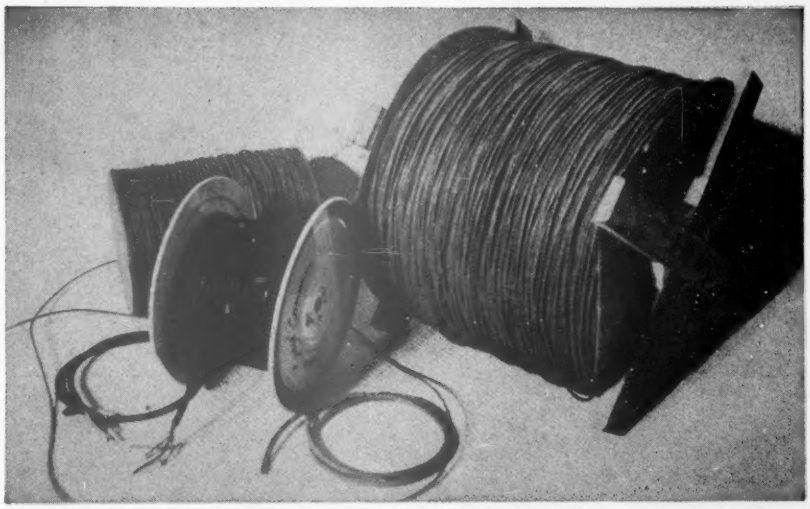
Figure 3

time period in the H.A.V. for the silcone rubber after vulcanization is inversely related to the H.A.V. temperature, no such relationship exists at normal C.V. curing temperatures. Even at 240 psi the insulation can remain in the vulcanizer for periods up to 150 seconds with only slight changes in physical properties.

Wire Train

The rest of the equipment used in processing silicone rubber wire insulation is the standard wire feeding and take-up equipment. This equipment is identical to that used to process organic insulation and can be excluded from

(*Please turn to page* 1432)



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Twitchell's superior Textilene line also includes: Fungus-resistant filler — *Twi-Tar*. Used for buried communications cable, expanded ACSR cable, and in other applications.

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*Patent No. 2832190

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Proved performance as components of cables and wires that meet government specifications . . . stability shown by trouble-free installations in continuous service 20 years and longer.

FREE — SAMPLE SPOOLS of any type of Textilene filler to demonstrate the superiority of Twitchell materials in your operation—also technical counsel without cost or obligation. Just tell Twitchell your end-use requirements. *Write, wire, or phone today:*

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Outstanding Personalities of the Wire Industry

Wire Machinery Expanding

Wire Machinery, Inc., 5407 South Knox Ave., Chicago 32, Ill., due to the tremendous growth of its business, is finalizing plans for the construction of additional buildings to house expanded production equipment.

At the same time new key personnel have been added to the organization. At present the management roster includes the following persons:

C. J. Muntwyler, Chairman of the Board
F. C. Muntwyler, President
Richard L. Jerrick, Vice Pres.-Sales
William R. Schieve, Vice Pres.-Devel. & Res.
A. B. MacFarland, Consulting Engineer
Richard C. King, Asst. Sales Manager
R. L. Fleshman, Chief Engineer

* * *

Mr. Jerrick reports that the expansion of facilities and personnel has been due to the qual-

Left: C. J. Muntwyler
Right: F. C. Muntwyler

Left: William R. Schieve
Right: A. B. MacFarland

Left: Richard C. King
Right: R. L. Fleshman

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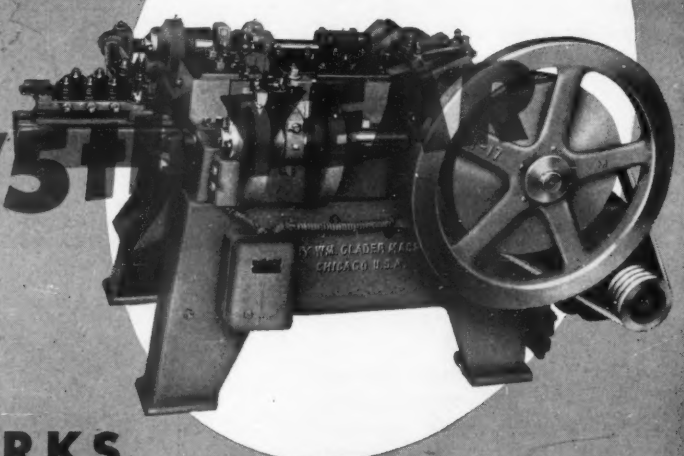
Eliminate costly down-time in the Nail Mill by replacing obsolete machines with new GLADER NAIL AUTOMATICS. For tops in efficiency and economical operation use GLADERS.

OUR 75th



WM. GLADER
MACHINE WORKS
210 N. RACINE AVENUE • CHICAGO 7, ILLINOIS

EXPORT DEPT., 122 EAST 42nd STREET, NEW YORK 17, N. Y.

Richard L. Jerrick

ity of the company's products, their acceptance by the wire industry and their extensive adverising in Wire and Wire Products.

* * *

In addition to producing a complete line of machinery for the wire industry, the company acts as distributors for Whitacre Dead Blocks, Prutton Thread Rollers, and Patterson Straightening and Cutting Machines.

Named Plant Manager

Russell Link has been named general manager of Central Steel & Wire Co.'s Detroit plant, succeeding **John E. Daniels,** who has retired after 28 years with the company. Mr. Link had been sales manager at the Detroit plant.

Appointed by Autolite

George Friend has been named Quality Control Manager for **The Electric Autolite Company's** Wire and Cable Division, according to **R.A. Olsen,** division general manager.

* * *

In this newly created post, Mr. Friend will be responsible for the coordination of all functions and efforts of quality control in the Company's three wire and cable facilities.

* * *

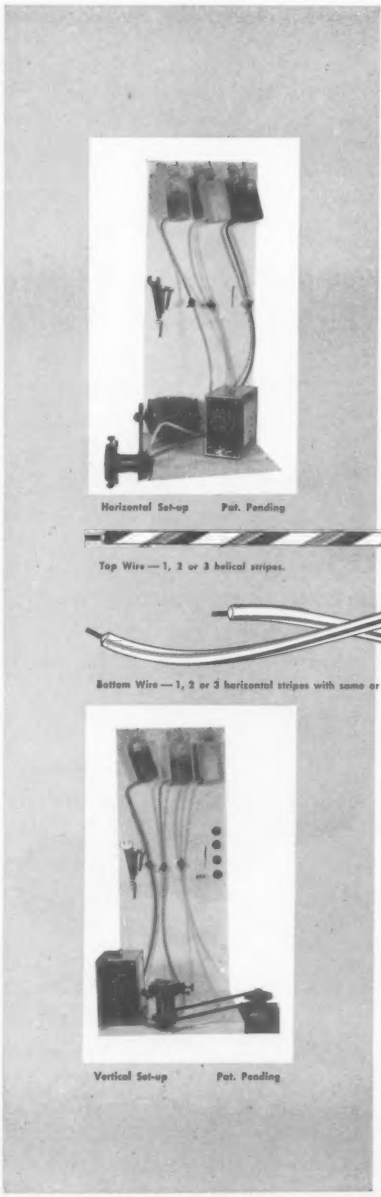
Mr. Friend, who has been quality control manager at the Port Huron plant since 1959, joined Electric Autolite in 1943 and has worked in the factory and in the Engineering Department. He attended the Ohio Mechanics' Institute, where he studied quality control at the University of Cincinnati. He is a member of the American Society for Quality Control.

Union Drawn Steel Names New Chief Engineer

Glenn A. Johnson has been named chief engineer for Republic Steel Corp.'s **Union Drawn Steel Division, Tom M. Girdler, Jr.,** Union Drawn manager, announced. With his office in Union Drawn's headquarters in Massillon, Mr. Johnson will direct all engineering activities at the division's plants in Hartford, Conn.; Beaver Falls, Pa.; Gary, Ind., and Los Angeles, Calif., as well as the two Massillon plants.

Named N.Y. District Manager for Page

T. P. Bronco has been appointed district sales manager for the New York District of **Page Steel and Wire Division** of American Chain & Cable Company, Inc.,


Horizontal Set-up Pat. Pending
Top Wire — 1, 2 or 3 helical stripes.
Bottom Wire — 1, 2 or 3 horizontal stripes with same or varied widths.
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NON-CONTACT CONTINUOUS SPIRAL STRIPER!

For 100% Helical Striping

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Runs 1, 2 or 3 Colors Simultaneously!

Horizontal or Vertical Striping— Continuously!

Width of Stripe can be changed while running!

GEM GIVES YOU:

1. Years of research and know-how.
2. Most Modern Marking Machines, for insulated wire.
3. Marking Inks specifically compounded for this equipment.

GRAVURE GEM COMPANY, INC.

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Cable Address: GEMGRA

with headquarters at 230 Park Avenue, New York 17, N. Y., according to an announcement by **Ralph J. Teeple,** division sales manager for Page.

* * *

Mr. Bronco joined the Company April 1, 1958 and has been serving on the sales staff at the Page mill at Monessen, Pa. He attended Columbia University and is a graduate of the University of Pittsburgh and Duquesne University School of Law.

Joins Nelsen Steel as Director of Manufacturing

Glenn J. Kilcullen, a 25-year steel industry veteran, has joined **Nelsen Steel & Wire Co.** as director of manufacturing, it was announced by **Daniel B. Nelsen Sr.,** president of the Franklin Park (Ill.) firm.

* * *

He will supervise a stepped up manufacturing program that will enable the mill to offer a versatile line of cold-drawn steel bars. His responsibilities include procurement of raw materials, scheduling, quality control and production.

* * *

The Nelsen mill recently completed a large-scale expansion quadrupling its production capacity and making it possible for the company to manufacture a wide variety of steel bars up to 4 inches in diameter. Key move in the expansion was installation of what Nelsen described as "the world's longest, fastest and highest producing draw bench."

* * *

Mr. Kilcullen, who has held a number of supervisory and executive positions during his career in steel, comes to Nelsen from Jones & Laughlin Steel Corp. He was associated with Monarch Steel Co. for 20 years, 15 of them in Indianapolis and 5 in Hammond (Ind.), before Monarch's merger with J & L.

Brookfield Wire Appointments

Brookfield Wire Company, Brookfield, Mass., has announced that **Howard J. Atkinson,** formerly Regional Sales Manager, has been appointed General Sales Manager, and that **Hermon Masuzzo** has been named Sales Representative for the New England territory.

Textile Machine Works Appointments

Textile Machine Works has announced the establishment of two new positions and the following promotions.

* * *

Vincent Scalese has been promoted from Manufacturing Engineering Manager to Production Manager of Textile's machine shop operations, reporting directly to **Albert E. Edwards,** Vice President-Manufacturing.

* * *

Richard C. Bodney, who was Mr. Scalese's assistant, succeeds him as Textile's Manufacturing Engineering Manager, while **Richard L. Hornberger** will assist Mr.

Wm. McCaskie, Inc.

NEW METAL BOUND CONSTRUCTIONS FOR HIGH SPEED PROCESSING, WATER TANK TESTING, RETURNABLE SHIPMENTS.

12" TO 48" DIAMETERS

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BEdford 4-7224

Bodey as assistant manager.

* * *

John W. Warren is the new Operations Manager—Foundry, also reporting directly to Mr. Edwards. He has been on special assignment as the Foundry's Production Manager.

Anderson Named President of Bliss

Carl E. Anderson has been elected president and chief executive officer of **E. W. Bliss Company,** a major manufacturer of industrial machinery, it was announced by **William L. Less,** chairman of the executive committee. Mr. Anderson was also elected to the Board of Directors of the Company. **Robert Potter,** Chairman of the Board of Directors, has been serving as acting president.

* * *

Mr. Anderson was previously the Director of General Management Consultation for Ebasco Services Incorporated, worldwide management consulting, engineering and construction firm. He will make his headquarters in Canton, Ohio.

To Sell GE Silicones in West

James H. Morrison has been named sales representative for the Western Sales District of **General Electric's** Silicone Products Department. His office location will be 8555 E. Florence Ave., Downey, Cal.

* * *

He holds a B.S. degree in Chemistry from U.C.L.A. Prior to joining General Electric last May, he was associated with the Chemical Division of Goodyear Tire and Rubber Company as a salesman. He also served for four years as a development chemist in Goodyear's Tire Division, and for four and one half years as chief chemist with Kirkhill Rubber, where he was directly associated with silicone rubber fabrication.

Heads Research for Naugatuck Chemical

Dr. Charles D. McCleary has been appointed director of research and development for the **Naugatuck Chemical division,** United States Rubber Co., it was announced today by **F. Dudley Chittenden,** vice president of the company and general manager of its chemical division.

* * *

Dr. McCleary, formerly assistant director, replaces **Dr. Wesley S. Coe,** who has just been elected managing director of Petroquimica, S. A. (PASA). PASA was recently formed by five companies, including U. S. Rubber, to build a large petro-chemical complex in Argentina.

* * *

In his new post Dr. McCleary will head a research and development staff of over 300 scientists working in the division's laboratories or pilot plants in Naugatuck, Conn., Baton Rouge, La., Painesville, Ohio, and Bethany, Conn. Among the projects of his department are agricultural chemicals, plastics, synthetic rubber, latex compounds, reclaim rubber and solid propellants for rockets.

Agent: M. WIMPFHEIMER & SON, INC. 250 WEST 57th STREET, NEW YORK 19, N.Y. TEL. CIRCLE 6-9384

Insulating Wire and Cable with Silicone Rubber

(*Continued from page* 1427)

our discussion with that point in mind.

* * *

A device for dusting the finished wire is a small but important unit in the wire train. A mineral product like ground quartz is mechanically dusted on the wire before reeling. This prevents the reeled wire from sticking together.

Curing

Some wire constructions require an additional cure after vulcanization. The standard cure for most silicone rubber is a step cure through 480°F and is readily accomplished in a circulating air oven. During this oven cure, low polymer volatiles and any remaining vulcanization by-products are driven off. These volatiles are often detrimental to the rubber to a degree depending on the temperature of the intended application.

* * *

Care must be exercised in ventilating wire when it is being oven cured. Most silicone stocks lose several per cent of their original weight in low polymer volatiles. These volatiles when confined with the silicone rubber will cause degradation of the rubber. Therefore, ventilation of overwrapped wire which is going to be drum cured is essential. Vent holes can be placed at the end and in the core of the drum to help air circulate through the layers of wire. Even with proper circulation it is not good practice to build up a large number of wire layers when drum curing.

* * *

An oven used to cure silicone rubber should incorporate several features. It is desirable to have an automatic control to increase the oven temperature at a specified rate through the step cure, and a safety device to stop oven run away. The oven must have adequate internal air circulation and an exhaust system, vented outside, with enough capacity to prevent volatiles from reaching explosive levels.

* * *

The oven cure stabilizes the properties of the rubber and allows it to give better service at

EFFECT OF VULCANIZATION TIME AND STEAM PRESSURE ON TENSILE STRENGTH

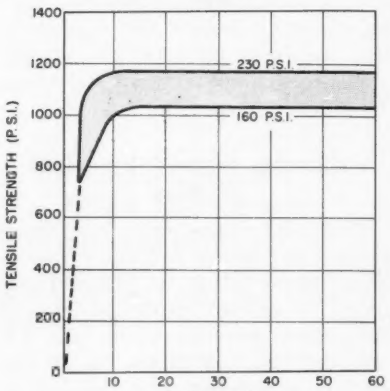
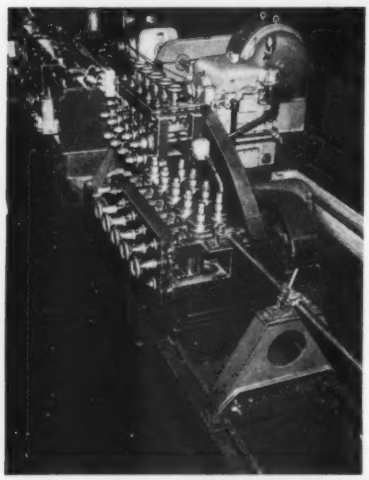


Figure 4 * * * * * * *

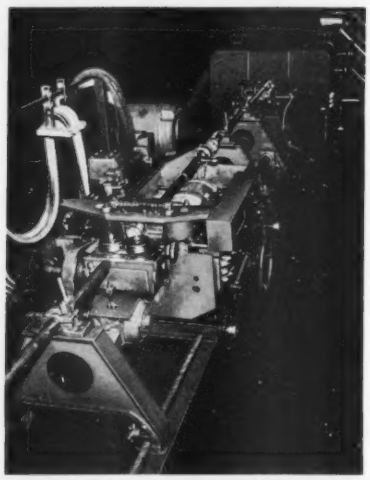
* Values based on a 2/64 wall insulation on a No. 18 stranded copper conductor.

LOMATIC

COMBINED DRAWING STRAIGHTENING CUTOFF AND POLISHING MACHINE



Payoff - Drawbench - Straightener



Flying Shear - Polisher - Discharge

Now available in two standard sizes, the revolutionary LOMATIC machines handle ferrous and non-ferrous rods and tubes at speeds up to 200 ft. per min. and with drawing capacities up to 16,000 lb. Compared to conventional separate rod drawing, straightening, polishing and cutting-to-length operations, the LOMA single-operation fully automatic machine offers the following major advantages:

- Greater output rate — continuous operation at high speed
- Reduced labor cost — only one operator required
- Improved straightness — stock is straightened in two planes
- Perfect concentricity — obtained by straight-line drawing action
- Higher surface finish — due to two-stage polishing unit

The complete line comprises an uncoiler, a pre-straightener, a drawbench, a roller straightener, a flying cutoff, a polishing machine and a discharge table. All components required for the complete sequence of processing operations are interlocked mechanically and electrically into one integrated and synchronized line which is controlled by only one operator.

Our standard line of equipment includes:

- Casting Machines and Molds
- Saws and Cut-off Machinery
- Hot and Cold Rolling Mills
- Rod and Tube Draw Benches
- Roller and Stretcher Levellers
- Air and Hydraulic Tube Testers

LOMA
MACHINE MFG. CO., INC.
114 East 32nd Street
New York 16, N. Y.

high temperatures. At present, a curing period is needed with most wire and cable stocks to meet government and underwriters specifications. This cure allows the physical properties of the stock to stabilize enough to meet the physical properties of the particular specification.

* * *

Curing silicone rubber in a properly constructed oven has a variety of effects on the physical and electrical properties of the rubber. No one set of standard cure procedures exists. The effect of cure can be summarized by some specific conclusions. Cure causes the elongation of most silicone rubber stocks to decrease and the tensile strength to increase. The change in the tensile and elongation properties is caused by continued crosslinking of the polymer. The decrease in elongation is greater with higher cure temperature and decreases steadily with longer cure time (Fig. 5). The gain in

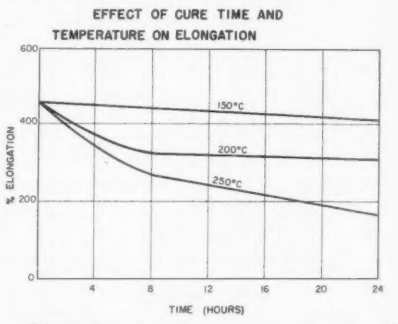


Figure 5 * * * * * * * *

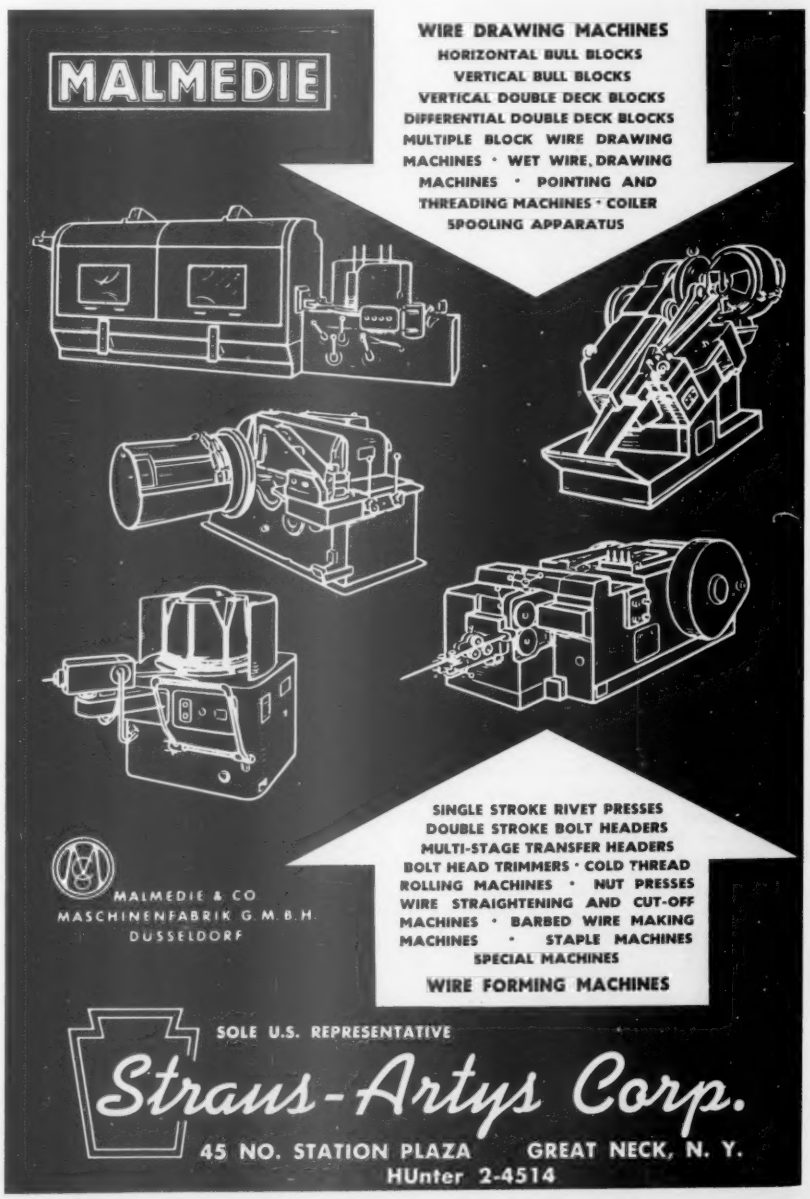
tensile strength increases slightly with increasing cure temperature. The length of cure time which gives optimum physical properties varies with the specific stock (Fig. 6). Oven cure also has an effect on the electrical properties of silicone rubber. The insulation resistance of cured wire increases with the length of cure time to an optimum point and then levels off with most stocks (Fig. 7). This increase in IR follows the same general curve at various cure temperatures but higher temperature cures give higher IR values.

Testing

Silastic wire is tested to compare its electrical qualities with other forms of insulation and existing specifications. The major electrical tests are the determination of electric strength and insulation resistance. Other electrical tests measure silicone rubber's resistance to environmental conditions. Typical are tests measuring electrical properties after the insulation has been immersed in water for periods of time. The electrical characteristics of the silicone rubber insulation are measured after various temperature cures and extended heat aging. Other environmental tests also include voltage endurance, corona and ozone resistance and cold bend tests. More specific environmental tests are usually defined in specifications and are designed to closely duplicate in-service conditions. Such tests are incorporated when the specific situation demands them.

Applications

Finished silicone rubber wire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MULTI-STAGE TRANSFER HEADERS
BOLT HEAD TRIMMERS · COLD THREAD ROLLING MACHINES · NUT PRESSES
WIRE STRAIGHTENING AND CUT-OFF MACHINES · BARBED WIRE MAKING MACHINES · STAPLE MACHINES
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finds application in several broad fields. One area of application is in shipboard cable. The properties of moisture and flame resistance make silicone rubber applicable for power, control, and hook-up wire. Its radiation resistance also makes silicone rubber useful as atomic submarine cable insulation. Other military applications of silicone rubber include aircraft ignition, power and control cable. Silicone rubber's temperature resistance makes it an ideal choice for fixture and defroster appliance wire. Motor lead and electronic equipment wire round out the major uses for silicone rubber wire. Potential markets include building wire and power cable.

Future

The future for silicone rubber as wire insulation in new applications appears bright. New processing techniques are also being developed to make this wire. The advent of non-milling and non-postcuring stocks assures fewer complications and more efficient handling techniques for silicone rubber. Radiation and liquid vulcanization procedures promise improved processing techniques. The application of electronic control equipment holds promise for ease of handling and quality wire by close control of extrusion equipment. As the users of silicone rubber become aware of new applications and as research produces improved silicone rubber it will become more widely known and used.

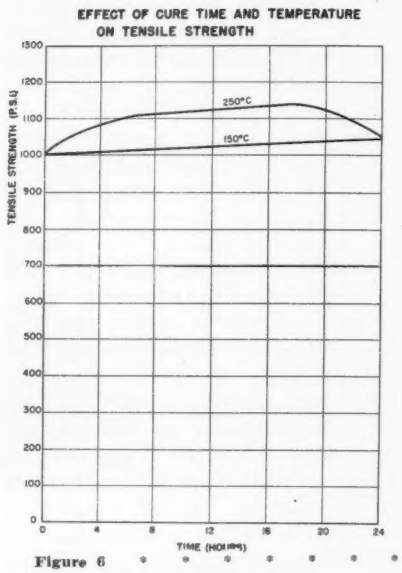


Figure 6

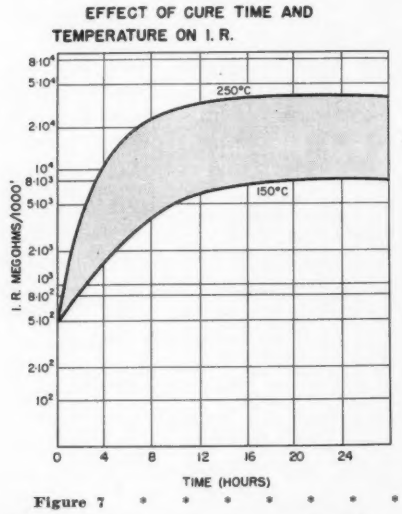


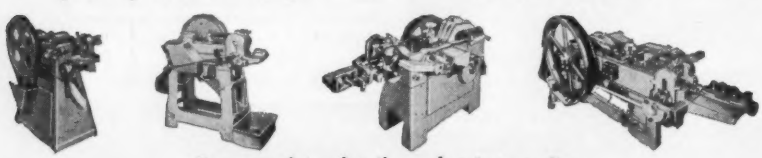
Figure 7

Summary

Silicone rubber has processing

The new Morris-Omega "00" SDDS Cold Header forms parts from wire down to .012" diameter in lengths as short as .016" — and at production rates as high as 150 per minute!

The Model "00" is only one of a series of precision heading machines, which includes a special open die type that will head parts up to 2⅜" in length on wire sizes from .020" to .090".



For complete details and prices, write:

REM SALES INCORPORATED

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properties comparable to most organic rubber wire and cable insulation materials. However, when processing silicone rubber modifications to the work area, the equipment, and the vulcanization and curing procedures do give best results. A clean work area is a necessity. Changes in extruder screw design increase extrusion efficiency. Vulcanization can be done either in a continuous steam vulcanizer or in a hot air vulcanizer. Hot air ovens are often used to finish the cure needed to meet certain specifications. This makes silicone rubber a practical insulation for those special applications where heat, radiation or electrical stress demand its unique properties.

New Strip Ovens Announced

The Carl Mayer Corporation has recently produced a new, gas-fired Preheat and Drying Oven for continuously processing 12,000 pounds of steel strip per hour. The ovens heat 24 steel strips moving at 60 FPM.

* * *

The strip surface is shot blast cleaned ahead of the Preheat Oven at 70° F. and heated to 450° F. by the Preheat Oven. The strip surface is then dipped in water based paint ahead of the Drying Oven at 150° F.

* * *

The strip is then heated in the Drying Oven to 600° F. to dry the paint. Both ovens are designed for maximum operating temperature of 750° F.

* * *

For further details, write The Carl Mayer Corp., 20,800 Center Ridge, Cleveland 16, Ohio.

Catalog on Turks Heads

The Fenn Manufacturing Company, 1 Fenn Rd., Newington, Conn., manufacturers of metal forming machinery, has published a new comprehensive catalog on Turks Heads, adjustable draw plates, that are widely used for forming accurate squares and rectangles directly from round wire and finishing special shapes or forming edge contours on flat metal ribbons.

* * *

The catalog contains detailed information on uses and applications, size control, surface finish, basic types, pull-through power sources, wire shaping mills, and case histories on actual installations.

* * *

Copies are available from the company.

The Swing to Aluminum for Electric Wire and Cables in India

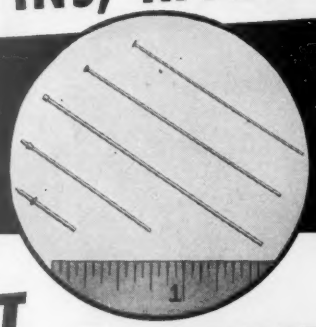
(*Continued from page* 1407)

Propaganda and On-The-Field Demonstration

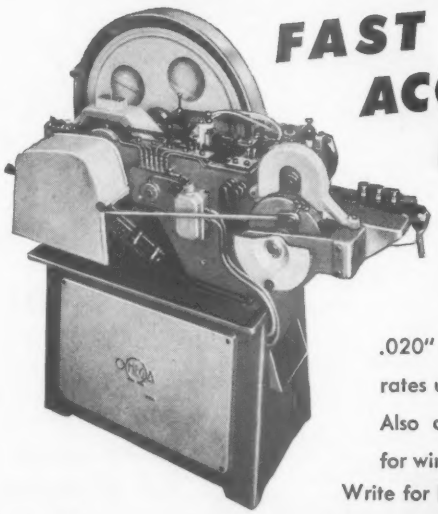
When CAC were first introduced in this country some engineers were hesitant to accept the new material, and bimetallic connections and application techniques were for a time posing problems. Complete wiring in-

LONG, THIN PINS, RIVETS

COLD HEADED



FAST ACCURATELY



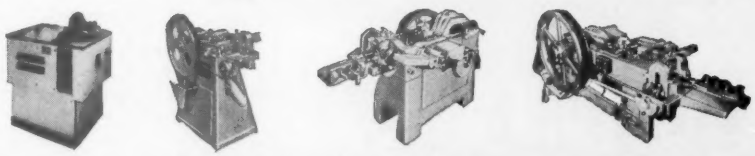
MORRIS-OMEGA

Special Model "O"

OPEN DIE Double Stroke Header, produces long thin parts in diameters from .020" to .090" up to 2⅜" long at rates up to 100 per minute!

Also available: Solid Die Headers for wire diameters as small as .012".

Write for literature.



For complete details and prices, write:

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stallations in prominent buildings and factories were, therefore, undertaken under the close supervision of the manufacturers' engineers. These trial installations proved highly useful in convincing the customer engineers of the successful performance and reliability of CAC. Technical literature and demonstration boards were circulated and linemen and wiremen were trained in the right installation techniques. Approval from various bodies like state electricity boards, insurance underwriters, military engineering service and posts and telegraphs department had to be obtained before these wires could be used in their respective systems. Efforts were also made to formulate standards in insulated cables on the lines of the British Standards, ASA and ASTM. The Indian Standards Institution have, as a result, evolved specifications for aluminium conductors in insulated cables and wrought aluminium for electrical purposes, and amendments to the code of practice for electrical installations on buildings, permitting the use of covered aluminium conductors.

* * *

Today, elementary questions[12] as to whether aluminium wires can at all be used for house-wiring are not likely to be asked even by people without engineering background. Approximately one out of every ten yards of insulated cable sold in India, at present, is aluminium-cored and with the increased targets for production of CAC, this proportion will go up to one in every three yards or four, in another twelve months.

Cable Industry In India

At the annual Wire Association Convention in October, 1947, Mr. S. S. Gill from India presented a paper on the Wire & Cable Industry in India. Since that day, the industry has made tremendous strides. In 1950, aluminium conductor manufacture was started by the Aluminium Industries Limited (ALIND), at Kundara, Kerala State. This unit at Kundara was completely engineered by the Aluminium Laboratories Limited, of Canada. The industry thus started under proper auspices, and had the benefit of the accumulated experience and know-how from probably the best source available in the Commonwealth at that time. Conductors and accessories of ALCAN designs were manufactured under the same roof; testing and quality control facilities were excellent. Since then, nearly a dozen more units have been licensed with a total installed capacity of over 40,000 tons of bare aluminium conductors per year. Some of the major units also fabricate their requirements of conductor-grade aluminium redraw rods; in conventional hot rod-mills, by Properzi continuous casting and rolling process, or by extrusion from billets. ALIND were the very first to set up a Properzi rod mill in Asia[13] and today, they operate two such units, one each at Kundara and Hirakud. They are also planning installa-

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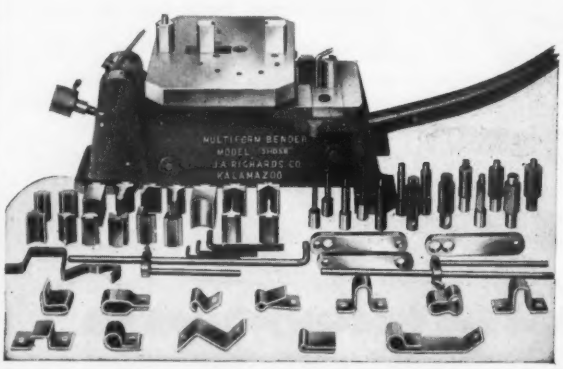

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At left is the No. 5HDSB MULTIFORM BENDER CUTTER. Capacity ⅛" x 1½".

tion of a third Properzi as part of their expansion programme for Kundara. Rods rolled by the Properzi process have been found satisfactory in every respect and can be used for even fine-wiredrawing down to 0.0076 in. dia.

* * *

Wiredrawing is done in all known types of wiredrawing machines — slip, non-slip, dry and submerged — at speeds varying from the lowest to 4,000 ft. per min. For fine aluminium wiredrawing, speeds up to 8,000 ft. per min. are possible. Aluminium wires 0.10 in. dia. and smaller are annealed at 350 deg. C. for one hour before redrawing down to 0.029 in. dia.

* * *

ALIND are the only organization exclusively engaged in the manufacture, at present, of aluminium-cored insulated wires and cables, and when their expansion schemes are fully implemented, they will have a total capacity of 40-50 million core yards of this type of cables. They will, also, be the first unit in India to produce the new SOLIDAL type of aluminium solid sector-cored underground cable, designs for which have been developed by the ALCAN group in the UK.

* * *

Under governmental pressure and in view of the scarcity conditions prevailing for copper supply, most other cable manufacturing units originally based on copper are progressively switching over to aluminium.

* * *

Only one unit has so far been licensed for the production of aluminium-sheathed underground cables.

* * *

The cable industry in India has received during the past fifteen years considerable fillip, thanks to the integrated power and industrial developments being worked out under the Five Year Plans. The industry has availed of this opportunity to diversify its range and expand capacity, and will soon be able to compare itself favourably with similar organizations in the better developed countries of the world.

The Swing to Aluminium

We have already discussed elsewhere in this paper, the inexorable economic trends and pressure of events which have led India to launch a major and wholesale switch-over to aluminium from copper in the cables and wires industry. The die has already been cast and a decision has jointly been taken at the highest level between the government and the panel of cable-makers, to progressively curtail the use of copper, using more and more of aluminium instead. After all, India's copper ore reserves are meagre, while her known bauxite ore reserves are inexhaustible—totalling over 250 million tons.

* * *

The decision has been taken after several major deliberations and detailed technical discussions between government and representatives of cable-makers. Government have also taken advice from world renowned experts from TCM and from international organizations like the Aluminium Limited of

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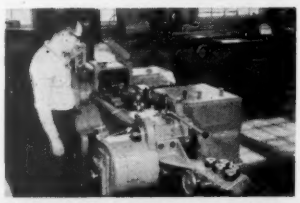
THESE GREENBAT HEADERS

HS Type Solid Die Single Stroke machines

...HAVE INCREASED PRODUCTION 200%

...AND REDUCED MAINTENANCE BY 50%



HS Type Solid Die Double Stroke machine

No. 3 (⅜") Solid Die Single Stroke machine

The world's leading producer of carbon steel bearing balls and shapes, Abbott has moved positively to ensure this leadership by installing versatile, high speed Greenbat heading machinery. In addition to the outstanding advantages cited above, Abbott has broadened its manufacturing capability considerably.

Available through the "Greenbat Sales Division" of Unitech Products, Inc., the famous Greenwood & Batley Ltd. line includes single, double, and triple stroke machines, head trimmers, friction presses, and thread rollers. Every machine is completely motorized and has a wire straightening feature as standard equipment. Other features include durability and speed comparable to any standard domestic machine, ease of tool setting and complete tool interchangeability with machines of other makes. They are supplied with American threads if desired.

You too can take advantage of Greenbat's low investment requirement, economy of operation, and outstanding performance efficiency. Investigate now by writing for complete data on your specific needs.

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Canada and some of the aluminium producers of USA.

* * *

The switch-over is being phased out into two or three stages so that within the next two/three years, practically all power cable produced in the country will have aluminium conductors. Special applications like control cables, mining cables, trolley and traction cables will, however, continue to be made in copper.

* * *

All the implications of the switch-over are being explored in a systematic and businesslike manner by the industry and the government.

* * *

Most governmental authorities have approved and accepted the use of CAC. The central purchasing organization of the Ministry of Works, Housing and Supply have included aluminium-cored wires and cables in the rate-contracts, enabling all governmental agencies to place their indents direct on the manufacturers without obtaining specific approval in each case. Manufacturers have undertaken to provide the necessary facilities for educating engineers and wiremen responsible for wiring contracts on the proper installation practices to be followed.

* * *

Even with only partial usage of aluminium for conductors, bare and insulated, the aluminium conductor industry is, today, the biggest single consumer of aluminium in the country. With the proposed wholesale substitution of copper, it is estimated that the total demand of aluminium for electrical applications will take up over fifty per cent of the total aluminium production/consumption in the country (60-70,000 tons out of 125,000 tons). This compares significantly with the situation in the USA where electrical usage ranks third among the consumers of aluminium. The time will be far off when in an underdeveloped country like India, building, containers and other consumer items exceed the power conductor demand for this plentiful and versatile metal.

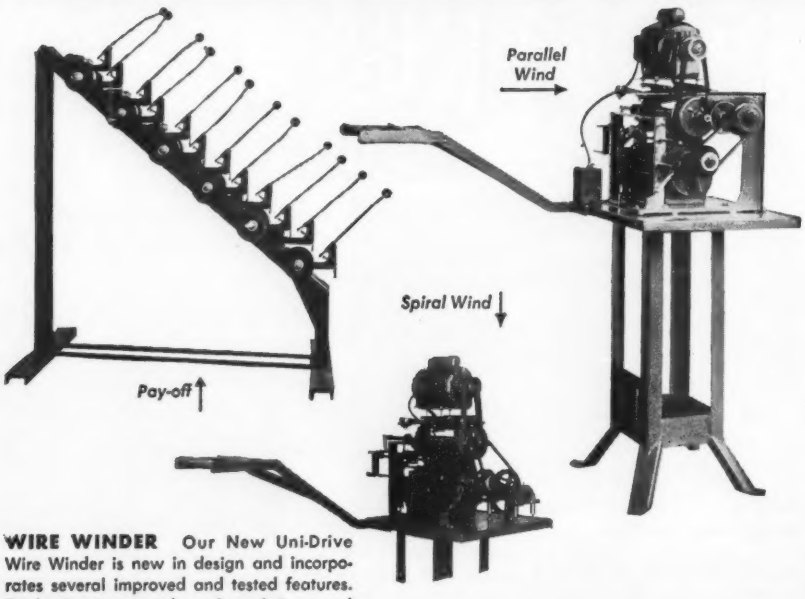
* * *

The switch-over from copper to aluminium in the electrical industry in India was started the day the first aluminium conductor manufacturing unit went into production in 1950. During the past eleven years, USA and most other countries of the world were in the grip of a copper shortage and were exercising their minds to the problems of substituting essential conductor items with aluminium. The situation in India has been more or less same except that the education of the engineers and the technicians inured to standard British practices all their lives, has taken a little more time and a lot more effort on the part of all concerned.

* * *

Everybody recognises that a whole-sale change like this involves problems. There will continue to be problems when established practices have to be altered and a new type of material has to be used in a man-

STANDARD UNI-DRIVE WIRE WINDER



WIRE WINDER Our New Uni-Drive Wire Winder is new in design and incorporates several improved and tested features. Production is stepped up through increased speed. It produces smooth, even and accurately wound spools of wire in single or multiple ends. All strands parallel — no over or under-winding. Can also be furnished with a slight spiral pattern for winding exceedingly fine wire. Automatic Stop Motion controls each strand. Traverse adjustable from 1¾" to 5½" between spool heads without changing cam. Designed especially for winding wire to be braided and shielded for electrical conductors.

Various types of supply packages that may be wound on Standard Uni-Drive Wire Winder.

PAY-OFF Our Pay-off Attachment consists of a heavy fabricated frame on which Pay-off spools are mounted to cover desired number of ends to be wound. Equipped with spindles, running on self-aligning ball bearings, with size of spindles and adapters to accommodate customers' pay-off spool. Compensating Attachment to control the tension of each individual strand of wire, applying the same tension when spool is full as when empty. Can also be adapted for use with bunching machines.

STANDARD MILL SUPPLY COMPANY
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ner slightly different from what one is accustomed to so far.

* * *

In a tropical country like India, the problems of electrolytic corrosion have been spelt out loudly from many circles, but it has been possible for the industry to establish that this difficulty can be got over with properly made contacts and with special greased, moisture-proof connections. Similarly, the difficulties in joining have been overcome by developing proper methods and practices which treat aluminium as aluminium—a little different from copper.

* * *

It is the engineers' mission to initiate the use and establish the adoption of materials and methods which will tend to improve in efficiency, and reduce the overall cost with consequent major economic gains to the nation. Better performance at less cost all the time all along the line should be the ideal. From this point of view, application of aluminium for electrical purposes has provided the industry in India and the rest of the world with unlimited possibilities, both in the manufacturing and in the research fields.

* * *

Much of the credit for the success of aluminium in the electrical field in India, as elsewhere, must rightfully go to the electrical engineering profession, who have boldly tried out the new materials, and willingly and wisely modified their practices to suit aluminium. There are still many more problems to be solved, and more milestones of progress to be crossed. In this great task, the cable industry continues to exert its utmost but will always look for lead and inspiration from the electrical engineers at the other end of the business circuit.

1. **"Parallel Paths of Progress for Aluminium and Electrical Industries"—The Aluminium Association. *Wire and Wire Products*, May 1961.**
2. **"Aluminium Conductor Industry in India"—V. G. G. Nayar, *Eastern Metals Review*, Annual Number, Feb. 1961.**
3. ***ALIND OVERHEAD LINES***
4. **Detroit Edison's ALUMINUM SUBSTITUTION PROGRAM — reprint from *Electric Light and Power*.**
5. **"Transactions of the World Power Conference, Sectional Meeting — 1951".**
6. **"Use of Aluminium Conductors in Rural Distribution" — S. Sankaran and P. N. Raman, reprint from the *ALIND Chronicle*.**
7. **"Rural Electrification in Madras State"—V. P. Appadurai.**
8. **"Erection of ACSR Pair on the 24-mile Experimental Line at Jabalpur"—V. R. Ananthanarayan and S. J. Louis, reprint from the *ALIND Chronicle*.**
9. **"Report on the Continuance of Protection to the Industry manufacturing Bare Copper Conductors, ACSR and AAC"—Govt. of India Tariff Commission, Bombay, 1960.**
10. **"Aluminium in Electrical Engineering"—J. C. Bailey, reprint from *Metallurgia*, Feb. 1955.**
11. **"Aluminium in House Service Overhead System"—S. Sankaran, reprint from *Electolite*.**
12. **"Good Questions about C A C and Good Answers by India's largest and pioneer makers of aluminium conductors".**
13. **"Certain Aspects of the Operation & Maintenance of Properzi Continuous Casting & Rolling Mill"—V. G. G. Nayar and K. R. K. Nair, reprint from *Wire & Wire Products*, October 1956.**

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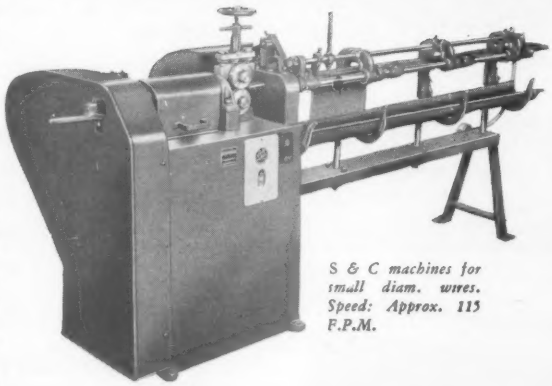

S & C machines for small diam. wires. Speed: Approx. 115 F.P.M.

This completely redesigned line combines maximum efficiency with that rugged dependability, for which WELLS S & C machines have become justly famous.

Built in several sizes to handle 2 to 18 ga. basic and high carbon wire.

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The guide bar of these new machines can be supplied for any cut lengths • The rotary flier runs on ball bearings for smoothness and long life • Cut-off is actuated by a solenoid for extreme accuracy of cut lengths • A two point cam construction provides a quick and positive return of the cut-off knife, eliminating the need for a clutch and dog • A counter is standard equipment.

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Correction

In the paper presented by Kenneth B. Brown on "Coatings on Stainless Steel and High Nickel Alloy Wires" at San Francisco on June 22, 1961, in Table I, which appeared on page 1078 of the August issue of Wire and Wire Products, certain important corrections have been called to our attention. The correct table is reproduced here, which includes a section on oxide removal.

TABLE I

METHODS OF REMOVING COATINGS AND LUBRICANTS

	18-8 STAINLESS	*INCONEL	*INCONEL "X"	*MONEL	NICKEL
LEAD	15-20% NITRIC 140-160°F 30 min.-1 hr.	15-30% NITRIC 140-160°F 30 min.-1 hr.	DO NOT USE	DO NOT USE	DO NOT USE
COPPER	15-20% NITRIC 140-160°F 30 min.	15-20% NITRIC 140-160°F 30 min.	15-20% NITRIC 140-160°F 15-30 min.	15-20% NITRIC 140-160°F CHECK EVERY 30 SEC. UNTIL Copper removed, RINSE	15-20% NITRIC 140-160°F CHECK EVERY 30 SEC. UNTIL Copper removed, RINSE
OXIDE	(1) SODIUM HYDRIDE (2) 10% SULPHURIC 15 min. (3) 20% NITRIC 5% HYDROFLUORIC CHECK EVERY MIN. UNTIL OXIDE REMOVED, RINSE	NOT USED	NOT USED	NOT USED	NOT USED
SOAP AND LIME	15-20% NITRIC 140-160°F 15-20 min.	15-20% NITRIC 140-160°F 15-20 min.	NOT USED	15-20% NITRIC 140-160°F CHECK EVERY 30 SEC. UNTIL COATING REMOVED—RINSE	15-20% NITRIC 140-160°F CHECK EVERY 30 SEC. UNTIL COATING REMOVED, RINSE
STEARATE	15-20% NITRIC 140-160°F 15-20 min.	15-20% NITRIC 140-160°F 15-20 min.	NOT USED	15-20% NITRIC 140-160°F CHECK EVERY 30 SEC. UNTIL COATING REMOVED, RINSE	15-20% NITRIC 140-160°F CHECK EVERY 30 SEC. UNTIL COATING REMOVED, RINSE
CHLORINATED PARAFFIN	TRICHLORETHYLENE VAPOR DEGREASE	TRICHLORETHYLENE VAPOR DEGREASE	TRICHLORETHYLENE VAPOR DEGREASE	TRICHLORETHYLENE VAPOR DEGREASE	TRICHLORETHYLENE VAPOR DEGREASE
MOLYBDENUM DISULFIDE	2½% NITRIC 2½% SULFURIC 15% HYDROCHLORIC IMMERSE 1 MIN. RINSE	NOT USED	NOT USED	NOT USED	NOT USED

NOTE: ABOVE MAY NOT BE THE ONLY METHODS BUT REPRESENT THE MORE COMMON METHODS BEING USED

* TRADE MARK THE INTERNATIONAL NICKEL CO.

To Sell Reynolds Products

Standard Brass & Manufacturing Co., Houston, Texas, has been named a general line distributor for **Reynolds Metals Company's** aluminum mill products — wire, rod, bar, sheet, plate, structurals and extrusions — in Houston and at six other locations in Texas and Louisiana.

* * *

Standard Brass has been an aluminum distributor for 11 years, also handling brass, copper and stainless steel.

Progress Report on the New Model 7 Properzi Equipment for the Continuous Casting and Rolling of Copper, Aluminum and Zinc

(*Continued from page* 1369)

EC metal. The kinetics of solidification are entirely different,

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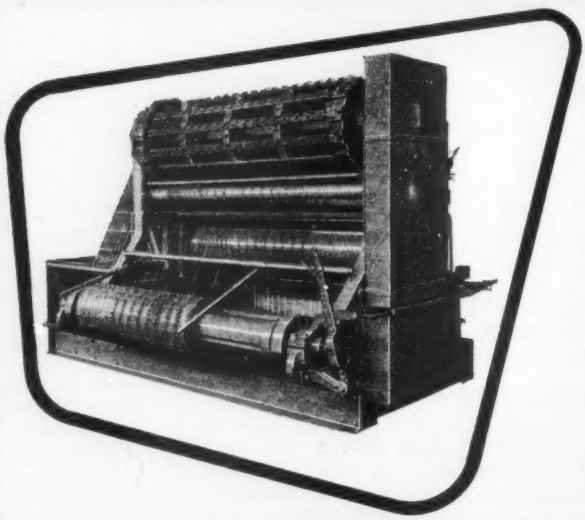

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particularly on the Properzi wheel where one is actually dealing with super-chill cooling at a casting rate in the order of 35 to 40 FPM. But these problems can be worked out with Model 7 equipment just as they were with the Model 6. As a matter of interest, at least 85% of Almelec conductor wire used in France (Almelec is similar to AAAC) is drawn from Properzi-made rod by Cie. Pechiney.

Acknowledgment

The author is indebted to Mr. Ilario Properzi and to his Chief Design Engineer, Mr. A. Lanfranco, for the assistance rendered in the preparation of this report. Except where otherwise indicated, all photographs and assembly drawings were supplied by Mr. Properzi.

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Variable Back-Twist in Rope Making Machinery

(*Continued from page* 1402)

turn transmission is connected with a gearing, thus it is possible to vary the ratio of the cage rotation and the backturn. It now is possible to use chain wheels, gear

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boxes or infinitely variable gearings for variation, the infinitely variable gearings being preferred.

* * *

With tube stranders a back-twist of 360° is achieved in a simple way due to the fact that the different spools or bobbins have their centres of gravity below the tube center line so that the complete cradle with bobbin is floating during the rotation of the rotor.

Quite a number of designs have been used that, however, did not prove satisfactory, so that they could not be adhered to. Primarily there was a design in which several transmissions had been located inside the rotor which then in turn actuated the different cradles by means of intermediate elements (gearings). The transmissions were driven from the rotor reduction gear unit as a function of the rotor rotation.

Another alternative is characterized by the feature that the reduction gear unit only operates the last bobbin as a function of the rotor rotation, wherein this drive is transferred by means of an appropriate intermediate gearing from one cradle to the other. In this method the transmission means required for the two solutions are subject to a high rotation and rolling stress

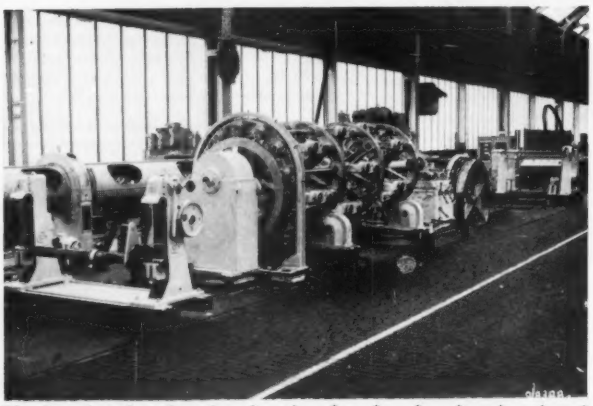

Fig. 7

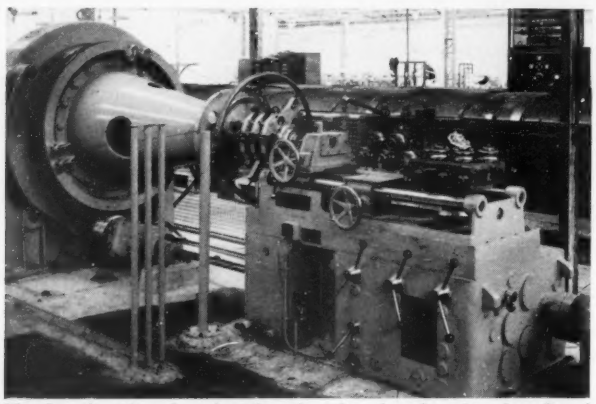

Fig. 8

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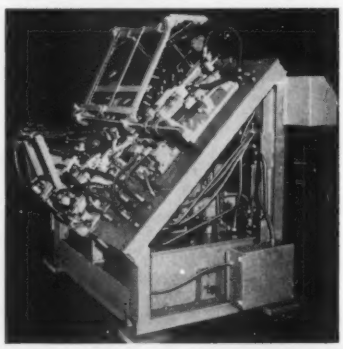
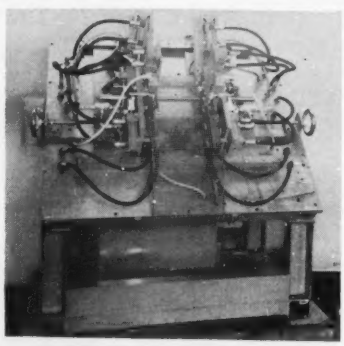


MODEL 375 — WIRE CAPACITY — ⅜" DIAM. PRODUCTION TO 1200 PIECES PER HOUR.

MODEL 250-WIRE CAPACITY — ¼" DIAM. PRODUCTION TO 1500 PIECES PER HOUR.



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whilst the required power transmission is but small. The problem of the rolling strength and the required silencing have,

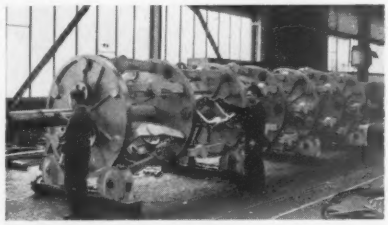


Fig. 9

* * * * * * * * * *

therefore, been a subject of major concern. Change wheels, gear boxes or infinitely variable gearings are also used for adjustment purposes.

* * *

However, in order to be independent of these mechanical devices a solution has been developed by using an electrical transmission (Figs. 10A and B).

Fig. 10A - Planetary Strander

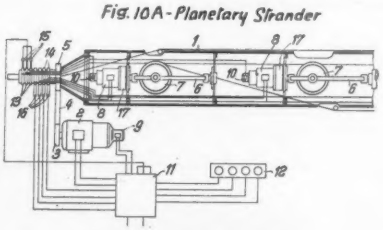
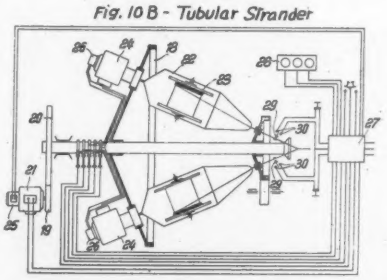


Fig. 10B - Tubular Strander



In this equipment each cradle is equipped with a motor whose stator top is connected with the rotating tube whilst its rotor (possibly through an intermediate gearing) is connected to the cradle. This motor is driven through adequate electrical devices as a function of the main drive. By installing adjusting means the cradles then also may be varied during operation either individually or combined in cradle groups or all cradles together. Although there do occur deviations from this dependence during starting and braking, such deviations are negligible because of their small percentage value in relation to the rotor rotation. Despite the relatively high expense involved for this electrical equipment it is quite recommendable and profitable in view of its favourable effects on economy (output of the machine).

* * *

Let me mention that recently a suggestion has been made to achieve the same purpose with hydraulic equipment. I for one hold the view that such a design would be rather difficult and unrational. In view of the fact that a variable back-twist involves special measures and equipment and that a deviation from the normal back-twist of 360°, as above mentioned, in many cases is not sufficiently large to warrant a special outlay in every case; the variable back-twist will remain a special feature which, however, is quite justifiable for certain ranges of production.

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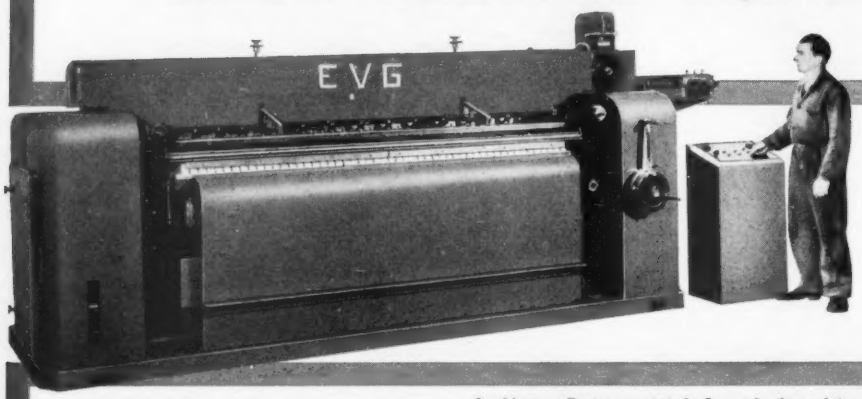

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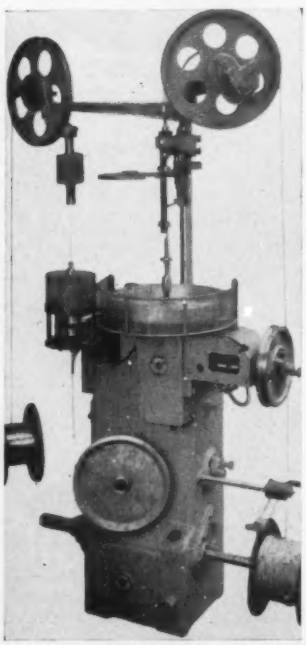

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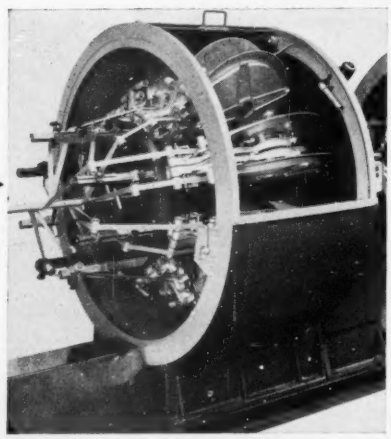

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Wire Electrogalvanizing Process at The Steel Company of Canada Ltd. Dominion Works

(*Continued from page* 1331)

9. While proper control of the process variables has almost eliminated the occurrence of such defects in actual production, examples presented here serve to illustrate the type of defects to be expected. Full understanding by the operating personnel of the various interrelated factors affecting physical appearance and properties of the deposit promotes careful investigation of such defects and the immediate correction of their causes.

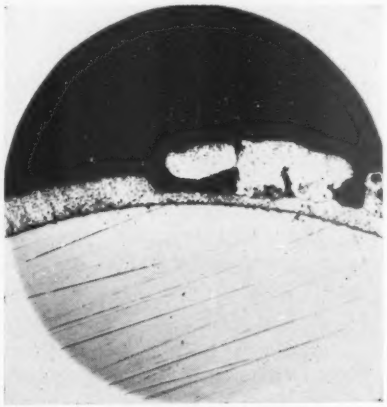

Fig. 9 — Example of coating defects due to adherent zinc particles on the wire surface. The presence of such particles inhibits plating in the immediate vicinity. Wire diameter .088 in., weight of coating 1.7 oz. per sq. ft. Etched in nital. Mag. 100X

* * * * * *

Air Agitation

Agitation is employed to maintain the uniformity of composition of the electrolyte, to equalize the temperature, to prevent objectionable stratification, to minimize the effects of hydrogen evolution and to permit the use of higher current densities than would otherwise be possible.

* * *

This is accomplished by means of compressed air delivered through perforated lead pipes located at the bottom of the plating tank. The compressed air is supplied by two compressors capable of delivering 220 cfm at 4 lbs. per sq. in.

* * *

Air agitation is adjusted to a low level of intensity since it also has some definite disadvantages. The introduction of air into the solution maintains an effective oxidizing atmosphere which promotes objectionable secondary chemical reactions. Another disadvantage is the tendency to keep dirt particles and anode disintegration products in suspension, giving rise to the roughness of the deposit.

Filtration

The necessity to maintain the electrolyte clean and free from impurities cannot be overemphasized. The origin of the contamination is in the anode impurities, zinc salts, and in the corrosion of the partially immersed equipment.

* * *

The purity of the electrolyte is maintained by a process of continuous filtration at the rate of approximately 45 gal. per min. so that the entire solution volume is filtered every 4-1/2 hours. As

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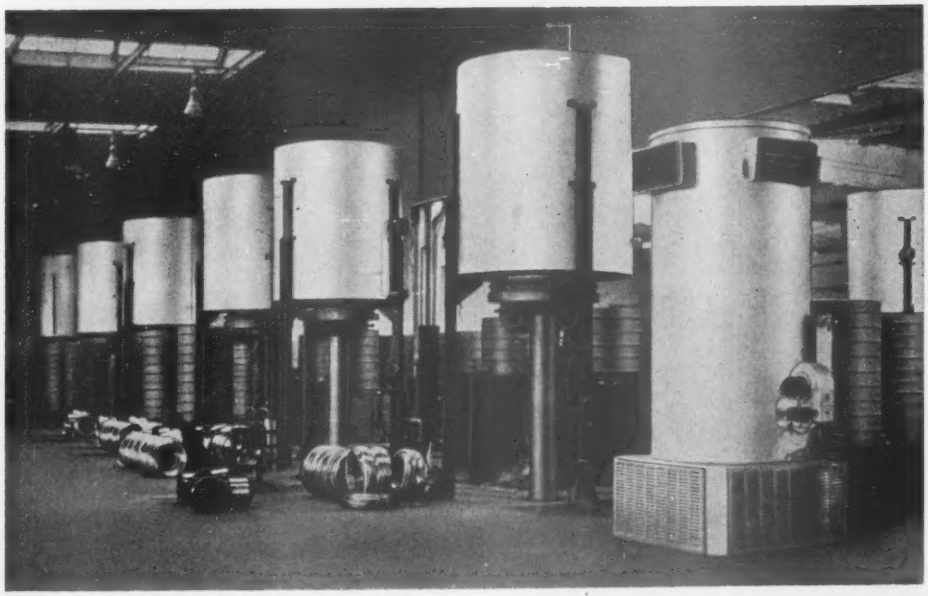

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an additional precaution the solution is batch-filtered at intervals combined with a thorough washing and rinsing of the plating tank after all solution has been withdrawn into the reserve storage tanks. Clean electrolyte is an important prerequisite to a top quality of the deposit.

Anodes

The zinc anodes are extruded from electrolytically purified zinc metal of high quality. The zinc content of the anodes is 99.99 percent minimum with the following maximum limits of impurities:

Iron	**.001%**
Lead	**.003%**
Cadmium	**.001%**
Copper	**.001%**

* * *

Generally, the purer the anodes the better and more trouble-free is the plating process. Zinc anodes are 40 in. long, 5-1/4 in. high and the thickness varies from approximately 3/8 in. to 7/8 in. This shape has been developed after extensive experimentation in an effort to reduce scrap losses and sludging. There is a total of 420 anodes in the plating tank, each weighing approximately 43 lbs. The consumption of anodes depends on the current strength and its efficiency. Theoretically they should dissolve according to Faraday's Law of Electrolysis, but in practice some anodes may become partially passive. The rate of consumption of zinc ions from the electrolyte will then be greater than the rate of dissolution of anodes and the solution density will tend to decrease.

* * *

Zinc consumption in 24 hours as a function of current is shown in Fig. 10.

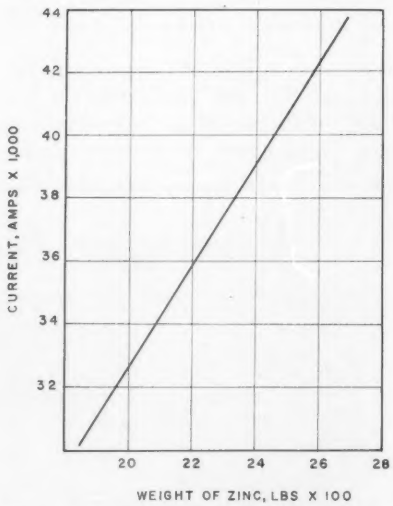

Fig. 10 — Zinc consumption in 24 hours in relation to amperage at 95 percent current efficiency. * * * * * * *

Rinsing and Drying of Wire

Since zinc coatings are subject to "white rust" corrosion the wires must be well rinsed and dried after emerging from the electrolyte. This is accomplished by means of both cold water spray and hot water rinse, with the latter being also a convenient method of heating the wires to evaporate the surface moisture. This is followed by a water-soluble "white rust" inhibitor which also enhances the finish and aids materially to retard the formation of "white rust" on

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the wire surface. Following this treatment the wires pass on to the hot air drier and then to the take-up unit.

The Take-Up System

The take-up unit consists of 28 conventional revolving take-up blocks of 24 in. diameter. An equal number of blocks located on both sides of the unit having independent drives permits a variation of speed. After the required weight of wire has accumulated on the blocks, they are stripped, the wire bundled, tagged, and samples cut for testing purposes. Wire is shipped only after being released by the quality inspection personnel. A general view of the take-up unit is shown in Fig. 11.

Factors Influencing Production

In planning production of a given type and size of wire on the electrogalvanizing unit the following factors must be considered:

1. **Wire diameter.**
2. **Required weight of coating.**
3. **Current magnitude.**
4. **Wire speed.**
5. **Length of plating tank.**
6. **Number of wires produced concurrently.**
7. **Current efficiency.**

* * *

Since the length of tank, the number of wires and current efficiency are constant, while the wire diameter and the required weight of coating are specified, only two factors are left to be considered as variables, the current magnitude and the wire speed.

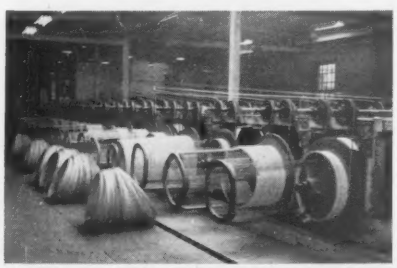

Fig. 11 — A general view of one side of the take-up unit showing coils of wire ready for bundling. Inhibitor treatment and drying equipment located on the steel framework above the floor level are visible in the background.

To maintain high efficiency of operation it is desirable to operate the unit at the fastest possible speed, thus obtaining the highest possible output per unit of time.

Determination of Speed

From the above considerations a simple formula for calculating the wire speed at a given current output can be derived:

$$S = \frac{I \times K \times L}{W \times Ac}$$

Where: S = Wire speed, ft. per min.
I = Current magnitude, amperes.
K = Constant (68.06×10^{-5} oz. per amp per min.).
L = Length of the plating tank, ft.
W = Required weight of zinc coating, oz. per sq. ft.
Ac = Total cathodic area of the wires, sq. ft.

Furthermore, if:

Bs = Block speed, rpm
C = Block circumference, ft.
T = Immersion time in plating solution, min.

the formula in terms of block speed in

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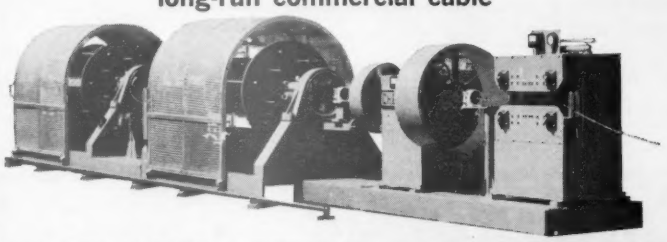

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rpm becomes:

$$Bs = \frac{I \times K \times L}{W \times Ac \times C}$$

and in terms of the required immersion time in plating solution:

$$T = \frac{W \times Ac}{I \times K}$$

* * *

The constant K can be derived from the electrochemical equivalents of zinc reported in Table I, and denotes the rate of zinc deposition at 95 percent current efficiency. The variation in the total wire cathodic area depending on the wire diameter has been reported in Table III.

* * *

Wire speeds employed depending on the specified weight of coating and the wire diameter at a constant current magnitude are shown in Fig. 12.

The Output of the Unit

The output is a function of the unit speed and the wire diameter, averaging approximately 450 net tons per month on a three shift basis. The variation in output of the whole unit with 28 wires running concurrently depending on wire diameters is presented in Fig. 13.

Quality Control

Determination of the physical properties, surface quality and the weight of coating on all products is carried out by the inspection and testing personnel immediately after a sample of the finished product is made available. Pilot tests are performed whenever necessary and controlling factors adjusted to suit the requirements as specified by the customer's orders.

* * *

Determinations of the weight of galvanized coating are performed volumetrically by the hydrogen evolution method. Physical tests are based on the respective requirements of the customer's specifications.

* * *

A series of controlling tests of the variable factors in cleaning and plating processes are also being performed on a periodical basis. The electrolytic solution is checked for temperature, pH, Baume, and the concentration of such ingredients as zinc sulphate, aluminum sulphate, ferric oxide and sulphuric acid. The cleaning acids are checked for acid strength, iron content, and temperature.

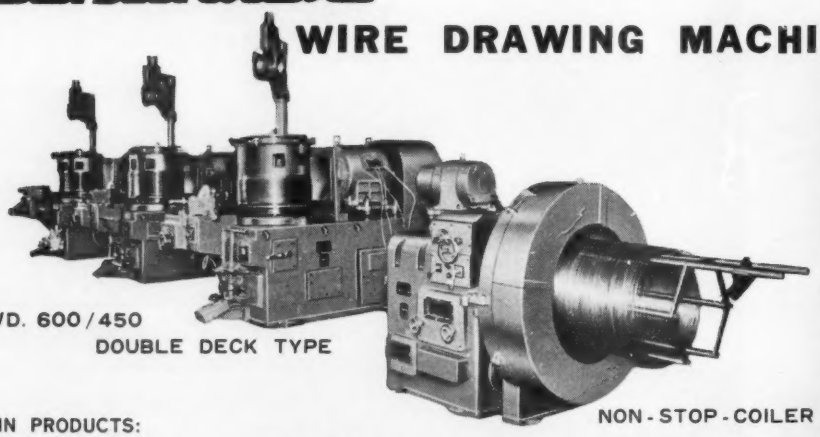
Acknowledgments

The author wishes to express his thanks to The Steel Company of Canada, Limited for permission to publish this paper. The valuable comments, continued interest and encouragement of **Mr. A. B. Dove,** Product Development Metallurgist, Finishing Works, and **Mr. E. G. Baker,** Chief Wire Metallurgist, is gratefully acknowledged. The author is also indebted to **Mr. H. C. Wade,** Works Metallurgist, Montreal Works and the metallurgical laboratory staff for their contributions and assistance.

Tanisaka

Continuous

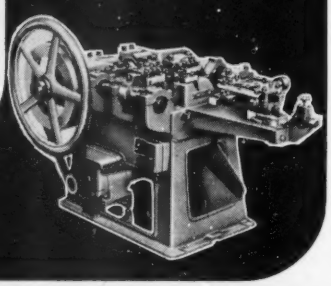
WIRE DRAWING MACHINE



CWD. 600/450
DOUBLE DECK TYPE

NON-STOP-COILER

NAIL MAKING MACHINE



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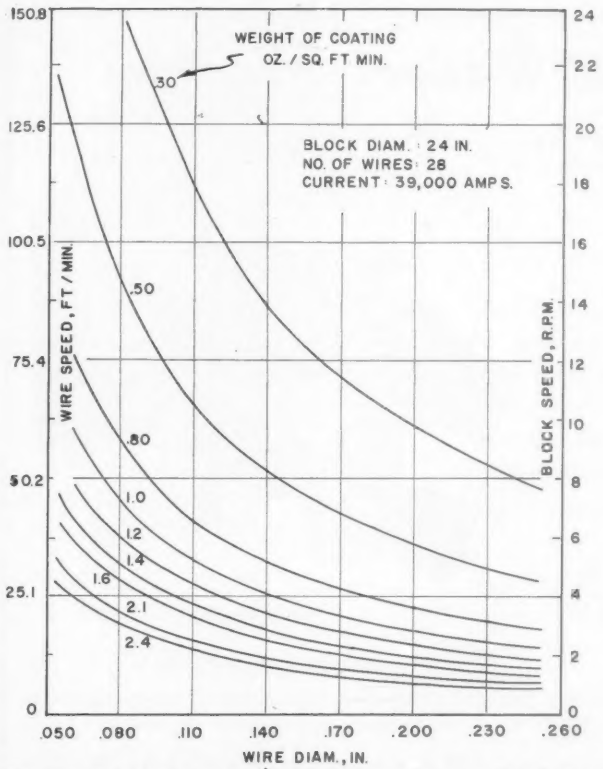

Fig. 12 — Weight of zinc coating in relation to wire speed and wire diameter. 28 wires run concurrently.

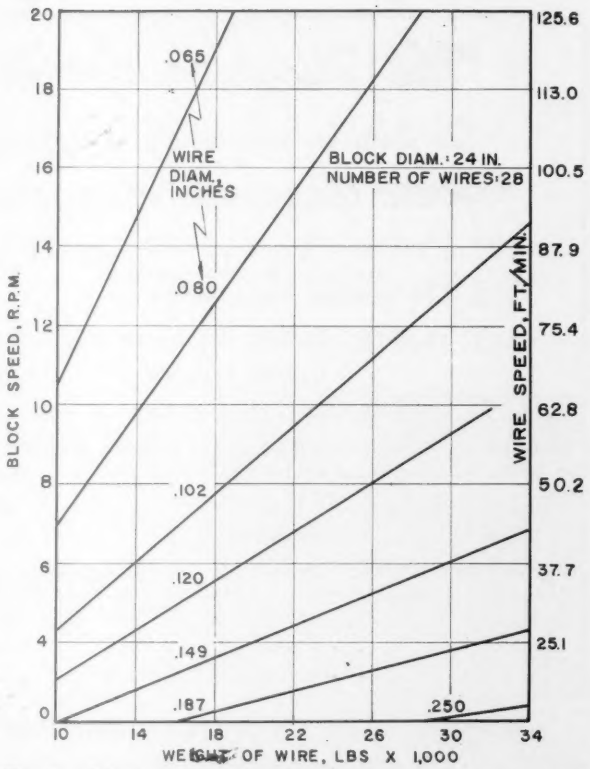

Fig. 13 — Output of the electrogalvanizing unit per 8-hour shift as a function of speed and wire diameter.

(*Please turn to page* 1452)

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Typical of the reports that come from rod and wire mills everywhere. Proof-positive that Porter has practically eliminated down-time for repairs. To cut maintenance costs and speed your cutting operations, it will pay you to get all the facts on the Porter one-hose HYDRAULIC ROD and BAR CUTTERS.

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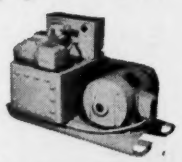

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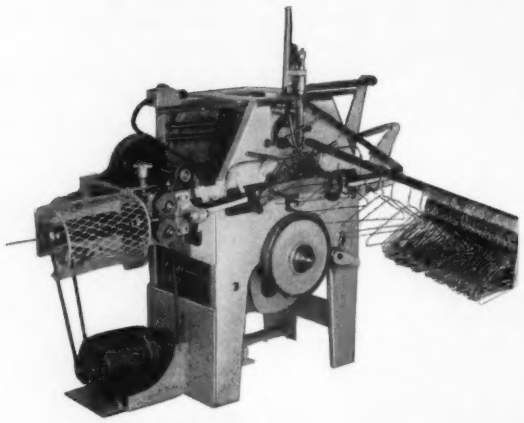

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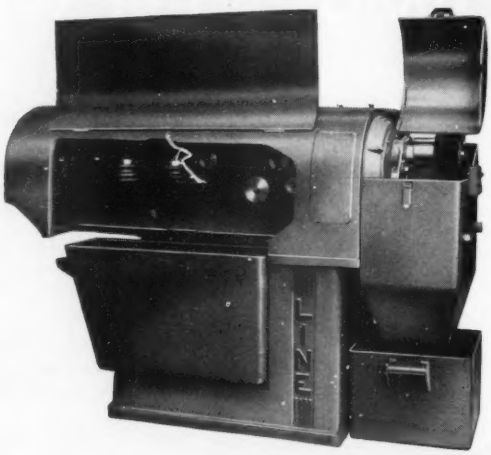

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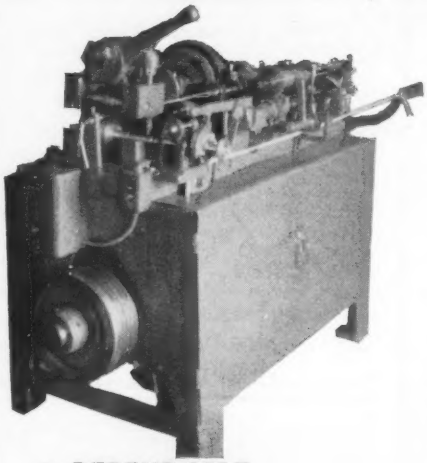

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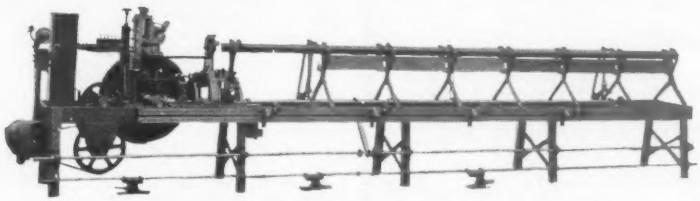

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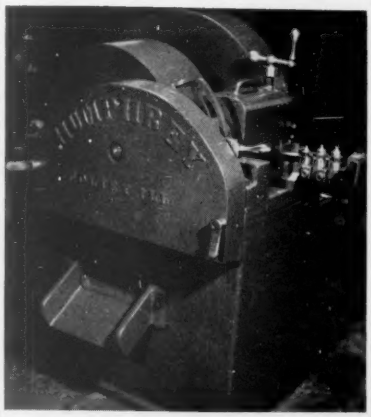

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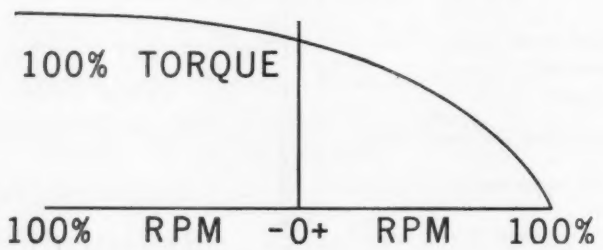

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2. Field, S., and Weill, A. D. "Electroplating—A Survey of Modern Practice" Pitman, 1951, 6th Ed.
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* Used generally, without citation.

Continuous Conveyorized Loop Processing—A New Concept in Rod and Wire Handling

(*Continued from page* 1335)

that, for the tonnage involved, the cost in dollars per annual ton would substantially exceed that of the loop system installation. At the present time, the factor which limits the rate of production is the speed at which the rod may be paid off from mill coils. Any improvement in the winding of mill coils which will permit higher pay-off speeds will be reflected in increased capacity of the line. This increase will in turn, result in a reduction of capital investment as expressed in dollars per annual ton of rods cleaned.

* * *

In this first installation, an area adjacent to the wire drawing machines was available for the cleaning facilities. The dimensions of this area were approximately 30 feet by 50 feet, with the longer dimension running along an outside wall. The line from the coiler to the collector, inclusive, was installed in the 50 foot space. The pay-off and welding station was located near the collecting end for the convenience of the operator. It should be noted here that the rod may enter the coiler at any desired angle. This fact permits locating and orienting the pay-off for optimum operating efficiency. The distance from the collector to the wire drawing machines is approximately 50 feet and the transfer is quickly

made using an overhead monorail system. This same overhead system is used for rod handling at the pay-off and welding station. Thus the requirement for utilization of available and limited space was fulfilled.

* * *

Due to the fact that the cleaning line was located in the same room as the wire drawing machines, it was necessary to keep acid fumes to a minimum. It has been found that, under a variety of temperature and humidity conditions, the cold acid cleaning has not created a fume problem serious enough to warrant special hooding or ventilation. Thus, maintenance problems are reduced when compared with those encountered with the use of hot sulphuric acid cleaning.

* * *

The plant in which this cleaning line was installed is in such a location that the dumping of effluents created a serious problem unless such effluents were within certain limits of acidity, toxicity and both dissolved and undissolved solids. It has now been rather definitely established that the mechanical descaling removes at least 90% of the scale, thus alleviating the burden placed upon acid cleaning. This is emphasized by the fact that acid consumption is only approximately 8 pounds of commercial muriatic acid per ton of rods cleaned. With a production rate of approximately 350 tons per week, it has not been found necessary to dump the acid tank more than once every four weeks. The spent liquor is dumped into a holding tank located directly beneath the rubber lined acid tank, where it is neutralized with lime and allowed to settle. A period of up to four weeks is thus available for the disposition of this liquor. In practice, after a reasonable settling period, the liquid is pumped through a 3000 gallon settling tank which allows further settling. The effluent from this process meets all of the requirements for dumping either into sewers or fresh water streams.

A RUGGED, DEPENDABLE
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Wire is easily "loaded" into measuring machine from the side or the rear without having to feed through guide bushings. Brake stops measuring wheel instantly when wire leaves measuring rolls. Predetermined units will automatically stop wire at desired length. Very accurate speeds to 2500 ft. per minute.

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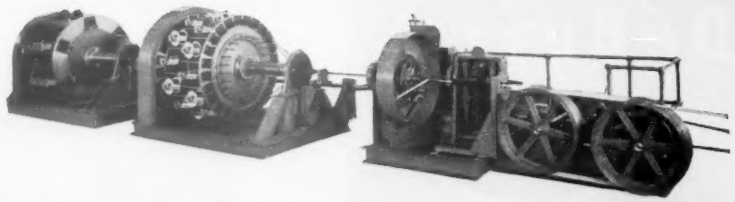

A very efficient machine built for producing cables where a small number of large conductors and a larger number of smaller conductors and fillers are used in the construction.

6-Cradle Section fitted with side opening cradles and accommodating reels 16 inches diameter and 9⅛ inches overall width.

24-Cradle Section fitted with fast loading and shaftless cradles having means for locking reels in place and eliminating side slap and accommodating reels 8 inches diameter and 5 inches overall width.

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This Planetary Cabling Machine is one of a number which we have built handling reels 8, 10, 12, 16, 19, 24, or 30 inches in diameter. We can supply Standard Units to meet practically all requirements.

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WIDE RANGE OF CUTTING SPEEDS TO HANDLE ALL FERROUS AND NON-FERROUS MATERIALS.

SHORT LENGTHS WHICH PREVIOUSLY HAD TO BE SCRAPPED NOW CAN BE SALVAGED.

- BENCH MODEL HANDLES WIRES 0.060" TO 0.250" DIAMETER.
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It has been found that approximately 75% of the chlorides to be disposed of are contained in the rinse water. The rinse water is continuously treated with lime slurry and the overflow is piped to the same settling tank described above. The solids settle out here and the effluent is nontoxic, clear, odorless and has a ph of approximately 7.0. The solids are removed periodically by a septic tank cleaning firm. However, now under study is a filtration system which will allow collection, drying and sale of the solids back to the steel producers. It therefore appears that acid disposal problems have been minimized.

* * *

From a labor standpoint, one operator and a helper maintain the continuous loop line, including procurement of rods, welding, operation of all line components and delivery of finished coils to the wire drawing machines. Another established cost item is an acid consumption rate of only 8 pounds per ton as mentioned heretofore. Although figures are not yet available, it is believed that the drying system employed results in greater fuel economy than is achieved in flash bakers. The big bonus, however, is in the 4000 pound stems of cleaned, coated, snarl-free rods that are delivered to the wire drawing machines. The only attention at the pay-off end required of the wire drawer is to place the stems in position and make one weld every 4000 pounds. This permits operation of more machines per wire drawer and eliminates down time due to rod snarls. It appears that the use of the Crum Continuous Conveyorized Loop system of cleaning has kept cleaning cost very low while at the same time it has increased the efficiency of the wire drawing operation.

* * *

Now under study is the insertion of rod and wire patenting facilities in the cleaning line. Although engineering and metallurgical studies are not yet

complete, they are sufficiently advanced that such an application appears to be entirely practical. The data shown in Table I may well apply to patenting 7/32" rods. If a lead or a salt quench is desired, an additional 10 feet or so should accommodate this treatment. The slow conveyor speed (5 feet per minute) should minimize drag-out of the quenching medium. Aside from the sizeable savings in space, all labor and handling chargeable to the conventional patenting operation would be eliminated. Preliminary tests indicate that patenting wire in sizes as fine as No. 20 gauge would be practical and extremely economical when incorporated in the Continuous Conveyorized Loop cleaning line. In patenting drawn wire it should be noted that the wire may be placed on the line direct from the drawing machine, thus eliminating one handling.

* * *

One non-ferrous application of the principles of the Continuous Conveyorized Loop system now being developed is the continuous drawing, annealing and collecting of aluminum process wire. In this case, .187" aluminum wire being drawn at 1500 feet per minute will pass directly from the finish block on the drawing machine to a coiler which will deposit the wire in the characteristic loop pattern on a conveyor. This conveyor continuously moves the wire through an annealing furnace and delivers it to a collector, where it is deposited on stems ready for re-drawing. This operation is fully continuous with no shut-down required for the removal of finished stems of wire. One extra dividend in this system appears when it is considered that the aluminum wire is coming off the drawing block at a temperature of approximately 300 degrees F. This fact substantially reduces the amount of heat required for annealing. In addition to the utilization of the heat generated in drawing, there now is eliminat-

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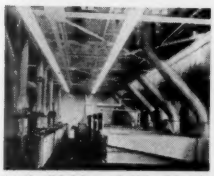
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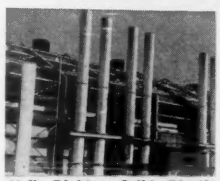
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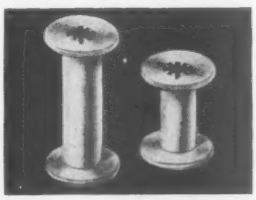

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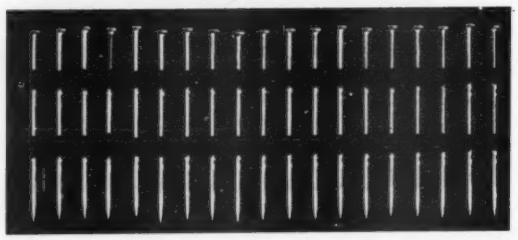

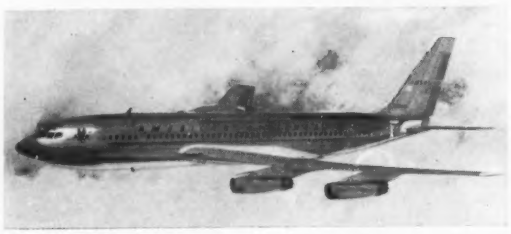

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ed the necessity for heating a spool which is commonly used as a carrier in batch process annealing and which might constitute one-half of the total weight to be annealed. Another premium is the advantage of drawing from a large, tangle-free coil through a dead pay-off, so that there need be no stopping for welding at the next drawing operation. In actual trials, .076" annealed aluminum wire has been paid off from this type package at speeds up to 2000 feet per minute.

* * *

The Crum Continuous Conveyorized Loop Processing system has opened up entirely new avenues of approach to continuous or in-line treatment of both ferrous and non-ferrous rods and wire. It appears practical to use this method for heat treating, including quenching and drawing, pickling, washing, coating, plating and most other wire treatments now applied in either batch or multiple strand methods. It also appears to be entirely practical to install this system in any multiple necessary to accommodate the requirements of any mill, large or small. In conclusion, the advantages that accrue through the use of this system are one or more of the following:

1. **Small capital investment**
2. **Low operating cost**
3. **Saving in floor space**
4. **Location in convenient space**
5. **High lineal wire speed**
6. **Low conveyor speed**
7. **Elimination of handling**
8. **Synchronization with wire drawing**
9. **Increase in efficiency of subsequent operations**

Production and Characteristics of Chemically Purified Hydrogen Precipitated Copper Powder

(*Continued from page* 1348)

To make good copper tubing the purity of the powder is most important. Rigid control must be maintained over carbon, iron, lead and tin impurities.

* * *

The powder is pre-blended with a lubricant keeping in mind the control of the above listed impurities.

Green compacts are made on a compacting press in the same manner bronze bearings are made and in the same range of operating pressures. In fact a compact which is later to become an extrusion slug is similar in appearance to a heavy walled porous bearing. The slug is designed for a 40:1 reduction ratio.

* * *

The green compact is sintered in a conventional belt-fed sintering furnace. Particular care in the control of the reducing atmosphere and the heating of the material is necessary. It is most important to remove the lubricant completely. Temperatures in the furnace are from 1850° to 1900°F.

* * *

The slug is hopper fed to a horizontal extrusion press. In extruding a slug to produce a ⅜" x .017 tube 60" long, pressure of approximately 125 tons is required. The production rate is 20 tubes a minute.

* * *

After annealing, the tubing made from powder will have a yield strength higher than conventionally made tubing and 10% better tensile strength. Tubing made from powder is stronger in these vital areas, as is true in strip made from powder.

* * *

The manufacture of strip and tubing is now ready for large scale production.

* * *

Further development is being carried on in alloying some of the so called "miracle" metals with Whitaker Metals powder that points to further important break throughs.

* * *

If I have accomplished nothing else today, I hope I have brought to your attention that there is on the market a highly pure copper powder with which wonderful new things can be done economically.

* * *

In my humble opinion copper and copper alloys are on the threshold of a new and intriguing frontier through powder metallurgy.

The author is indebted to Mr. Henry J. Tschirner, Exec. Vice Pres. and Genl. Mgr., Whitaker Metals Corp., and Mr. John D. Shaw, Pres., S. K. C. Associates, for their assistance in the preparation of this paper.

DIES AND NOZZLES FOR INSULATING ELECTRIC WIRE

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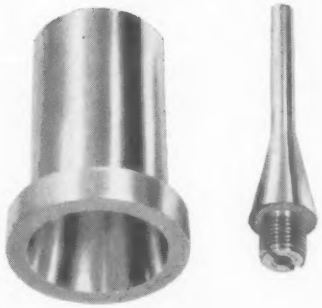

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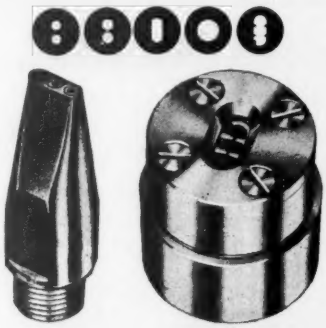

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Wire Former, #2-18 Baird, 4-slide, 1/8" dia. wire, 18" feed	684-31
Wire Former, #2 Nilson, 4-slide, approx. 18" feed, excellent	684-33
Wire Former, #1 Baird Four Slide	684-53
Wire Former, No. 1 Manville, 1/16" capacity, 4-slide	684-67
Wire Former, No. 3 Manville, 3/16" capacity, 4-slide	684-68
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Spring Coiler, No. 1 Sleeper & Hartley Universal Segment Type	684-05
Spring Coiler #2 Sleeper & Hartley, older, cheaper	684-76
Spring Coiler, W-3001 Torrington Torsion, New	684-12
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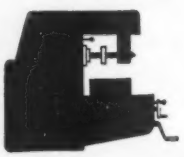
Expander, 52" Metal, Diamond size cap. 13-20 ga. (¼" x ¾" to 1" x 2")	684-48
Wire Flattening Mill, 4" x 2", 10 stand tandem, Waterbury Farrel	684-11
Descaler, Mechanica, .031-.375 gauge rod, New '56, Excellent	684-14
Chain link fence weaving machine, Blashill, New '54, Excellent	684-22
Spring Grinder, Carlson No. 1, .010-.125", like new 1960, used 3 mos.	684-65
Fence Machine, Cattle, 9 ga. wire, 42-48" width, cap. 9¾ ga.	684-61
Swager, No. 3A Fenn, 1¾" tube x 2½", Serial 545, New 1951	630-04
Swager, No. 4A Fenn, 2¼" tube, New 1952, Excellent	630-05
Swager, No. 5F Fenn, 3⅜" tube, 1½" solid, New 1953	630-03



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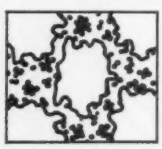
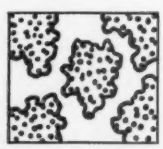


Simple mechanical mixture of molybdenum disulfide in a dry stearate compound.



BEMOL compounds with molybdenum disulfide particles locked into dry stearate compound.

Because moly particles were not an integral part of each metallic stearate particle, previous moly-stearate compounds caused irregular production results and wire finishes. Now with moly locked into each stearate particle, an even flow of die saving moly assures consistent and improved drawing performance.

BEMOL *Pioneers with Molybdenum Disulfide in Wire Drawing*

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Oil Tempering High Carbon Spring Wire with a Nitrogen Atmosphere Hardening Furnace

(*Continued from page* 1376)

and about one foot in depth. The fire-box is divided into two separate zones, each independently fired and controlled, with vents provided in each zone. The lead temperature may be adjusted and maintained from 800° F. to 1050° F., depending on wire size and ultimate physical requirements expected for each grade of oil tempered wire being processed. Chart (D) illustrates the basic functions of drawing temperatures.

* * *

The wire being oil tempered is submerged in the molten lead and thus made to travel to the take-up block at the prefixed rate of speed, in accordance with the ultimate physical requirements expected. Chart (E) illustrates the basic functions of drawing speed.

* * *

On the way to the take-up block, the wire is made to emerge from the exit sinker of the drawing furnace, through a wiping embankment of fine anthracite, at an approximate 45° angle to the water cooling tower, approximately 3' x 4" by 5' high, provided with a recirculating water pump, then to the surface oiling (g-1) tower, about 7 feet high, provided with revolving sheaves, flotating in an oil reservoir. * * *

The take-up block unit is of the conventional type, about 45 feet in length. It provides for interchange of blocks ranging from 72" maximum to 16" minimum, and a speed ratio contained from 9 ft./m. to 90 ft./m. The unit is serviced by overhead electric cranes, and hydrauling cutter.

* * *

In the oil tempering building a Tinius-Olsen, "3 range" testing machine with 3,000 to 120,000 lbs.-break capacity allows 100% pretesting of all the wire stock to be oil tempered, as well as 100% testing on all finished oil tempered wire, while processing.

The Properties of Copper-Titanium Alloys

(*Continued from page* 1383)

ly desirable not merely as a substitute, but in its own right.

First of all, it should be pointed out that the foregoing discussion has been limited to consideration of a simple binary alloy. Aside from the straight brasses and bronzes, nearly all commercial alloys utilize at least one additional minor alloying element to enhance some particular characteristic of the material. Although a very limited study has indicated that improved hardening response of the copper-titanium could be obtained with small additions of iron or aluminum, this entire area of improvement through minor alloying additions is essentially unexplored.

* * *

Secondly, there is the promise of improved elevated temperature properties. Measurements of room temperature hardness after 1 hour exposure to various temperatures have shown that for temperatures up to 850° F, the original as aged hardness of the copper-titanium is not altered. Also, tensile tests conducted at 400° F (1 hour exposure) have shown no significant loss of strength.

* * *

And last, but by no means least, is the strictly economic potential of copper-titanium. Assuming that the bulk of the processing costs of copper-titanium and copper-beryllium would be comparable, the primary factor governing a potential price difference would be the cost of the raw materials. Copper-beryllium is currently priced at approximately $40 per pound of contained beryllium plus the cost of the copper. Titanium sponge, on the other hand, can now be bought for slightly less than $2 per pound. As for using titanium scrap as an alloying material, it can only be estimated that if a market were developed for it, it should be expected to sell for substantially less than $2 per pound. In any event, it can readily be seen that for 100 pounds of alloy, the cost of titanium would be approximately $12 while the beryllium in the 2% copper-beryllium alloy would cost $80 and even in the lower strength 1% beryllium alloy, it

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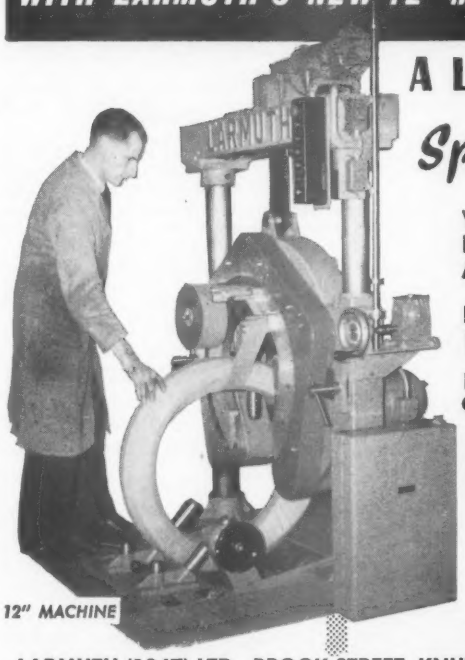

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* * *

Although a truly commercial evaluation of copper-titanium alloys would involve a large amount of further work, such an economic potential can hardly be overlooked.

References

1. W. B. Steward, Jr. and R. C. Harris, "The Preparation and Properties of Experimental Binary Copper-Titanium Alloys", Frankford Arsenal Report No. R-1323, June 1956.
2. H. R. Pritchard, "Mechanical Properties of 6 Percent Copper-Titanium Alloy Strip and Bar", Frankford Arsenal Report No. T-60-4-1, September 1959.

Semiconductive Compounds for Wire and Cable Extrusion

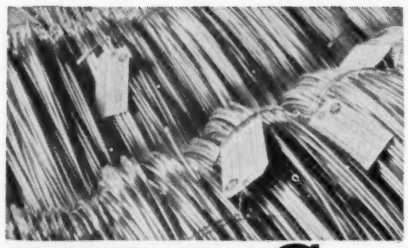
(*Continued from page* 1387)

light. By using each material as a conductor and by inserting a voltmeter in the circuit, it is possible to measure the voltage drop when each material is used to activate the fluorescent light. The brightness of the light visually confirms the differences in conductivity among the three materials.

Extrusion

Bakelite* semiconductive polyethylene compounds are processable on standard wire and cable extrusion equipment, but because of the high loading of conductive carbon black, more power than normal is required. Table II lists the recommended extrusion conditions for the semi-conductive compounds. Note the reverse extrusion conditions in which the higher temperatures are required in the center and rear zones (400° F. - 450° F.). These temperatures are required to flux the materials as rapidly as possible because of high filler content and to reduce the power requirement. A 2-inch extruder with a vinyl screw (constant depth, decreasing pitch) has been used most successfully. Again because of high filler concentration, no screens or the use of coarse screens are recommended. As with all conductive plastic materials, careful extrusion is necessary to maintain the conductivity of the materials, since high

* The term "Bakelite" used in this paper is a registered trademark of the Union Carbide Corporation.



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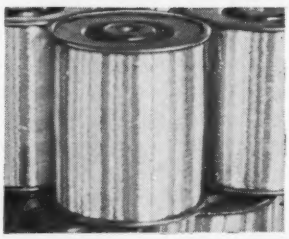

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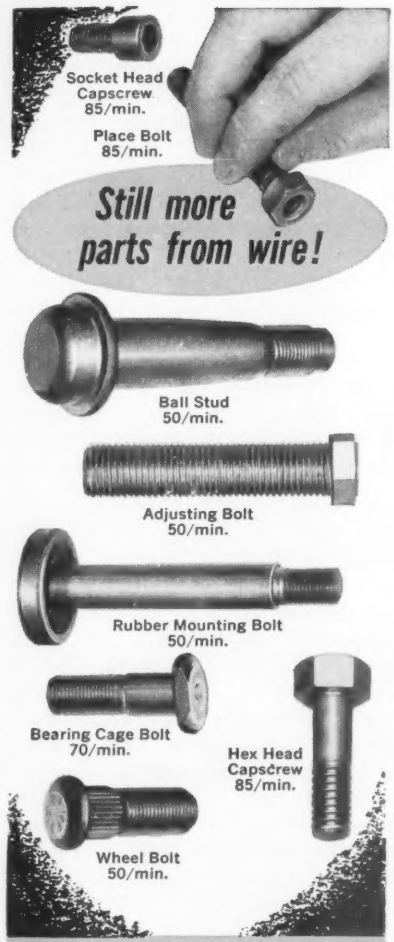

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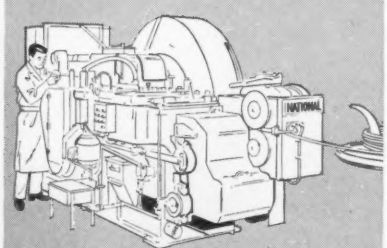

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shearing stresses or excessive working will lower the conductivity of the carbon black filler used. Conductive carbon blacks are sensitive to moisture pick up, and for this reason it is recommended that semiconductive materials be stored in a dry location and hopper dried prior to extrusion. Excessive moisture may cause porosity. Stock temperatures no greater than 365°F. are recommended.

* * *

While die, head, and breaker plate temperatures of 250° F. are shown in Table II, these are actual conditions obtained only from a short run. It is anticipated that these temperatures will rise for longer runs, but should not be permitted to rise higher than the recommended stock temperature.

* * *

Because of the viscous nature of the compounds, it may be neccessary to preheat the cable or conductor being covered in order to prevent chilling of the material in the head or die. Care must also be exercised to extrude as close to the desired output diameter as possible since excessive drawdown will cause a loss of conductivity. The water trough must be close to the die, with the water temperature not over 70° F. for optimum cooling.

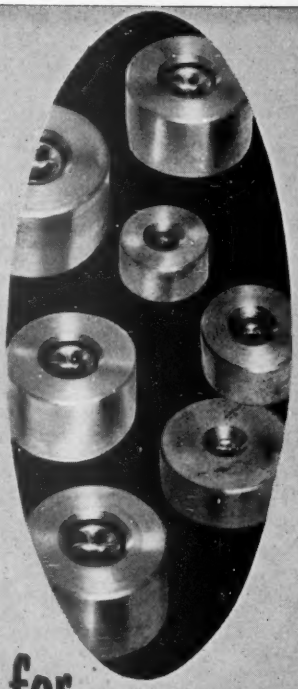
* * *

In summary, with reasonable care and the proper extrusion conditions, the excellent properties of Bakelite semiconductive polyethylenes should permit these materials to find application in areas where other semiconductive materials are unsuitable.

The Processing of Steel into Cold Heading Wire

(*Continued from page* 1392)

characteristic iron rim as described previously is used. This reduces the incidence of surface defects. While the melting process is generally the same as for the rimmed bolt stock, there may be an addition of manganese sulfide to the ingots during the rimming action for the purpose of increasing the sulphur content of the core of the finished wire. The relatively high sul-



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phur content of the steel contributes to ease of machining.

* * *

The subject of surface condition has been touched upon in discussing each of the above types of steel. Steps are taken throughout the process which are designed to give good surface on the finished wire. Control starts in the melt shop. Here mold preparation and pouring practice are important factors. Regulation of track time, i.e. the time the steel stays in the mold on the ingot buggy before being stripped, has a bearing on surface condition. The stripping of the mold is done with care to prevent damage to the surface of the ingots. Surface defects can be minimized by allowing adequate heating time and soaking time in the soaking pits, so the surface of the ingot is not burned and a uniform temperature is reached throughout. Defects which may be present in ingots are generally reduced in the rolling process. Blooms, billets, or rods having a defect resulting from a mechanical malfunction during rolling are either scrapped or diverted to a product where that particular defect is not critical.

* * *

A rigorous quality control program is maintained. The inspection personnel at our plant do not report to the head of any production department. They are established as a separate group responsible to the works manager. Observers in both melt shops keep a log of the melting, tapping, and pouring of the ingots for each heat of steel. Any irregularities, such as low pouring temperatures, or run-away ladle stoppers are reported. These people also observe and record the results of experiments performed to try new methods and test new material.

* * *

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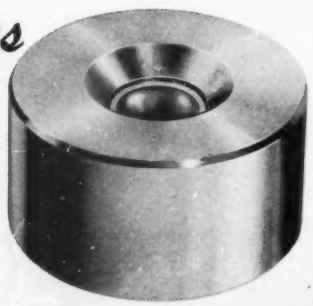

identity is maintained throughout rolling operations and can be traced through the wire mill and bolt plant if desired. A "rolling rating," or quality index, is determined in the blooming mill for each heat. This rolling rating is an arbitrarily designed measure by which the surface defects of billets to be rolled into rods for cold forging are evaluated. By this measure, a heat of steel may be accepted for its intended use or diverted into some other product. Upset tests are made at the rod mill on coiled stock. Coils on which the upset tests show cracks are set aside and individually examined. At this point, they may again be diverted to some other product use. In the wire mill, a visual inspection is made of the surface of the drawn wire to be certain it is suitable for the forging operation for which it is intended.

* * *

The processes which have been described are those of a single plant. Without question, other producers have other methods. Raw materials, differences in facilities, and differences in operating practice make this inevitable. Steel manufacturers are constantly searching for and testing new ideas in an effort to improve the quality of their products. As mentioned earlier, the manufacturers of cold-forging equipment and the manufacturers of fasteners themselves have done much in recent years to extend the versatility of the cold-forging process. In doing so, they have created a demand for improved forging wire. In spite of the improvements steelmakers have made in the soundness, uniformity, and surface condition of rods and wire, there is still much to be done in this area. In the years ahead, one can be certain that there will be further improvements made in cold forging rods and wires.

Correction

In the August issue, page 1010 mention was made that Robert W. Payne, Program Chairman for the 1961 West Coast Regional Meeting of The Wire Association, had been in Bethlehem Metallurgical Department prior to his transfer to the Sales Department in 1950.

* * *

He had been a member of the Metallurgical Department of **Columbia-Geneva Steel Division** of United States Steel Corporation before he was assigned to sales work for Columbia-Geneva.

To Represent Japanese Firm in the U.S.A.

Western Wire Corporation of Boston, 365 Dorchester Ave., Boston 27, Mass., has been appointed the exclusive representative in the U.S.A. for the NAS brand of stainless steel wire manufactured by **Nippon Stainless Steel Wire Manufacturing Co. Ltd.,** Osaka, Japan, according to an announcement by R. Dobrein, Executive Vice President of Western Wire.

* * *

The producer has a monthly capacity of 350 tons and can supply the wire in diameters of 0.625" to 0.0016" in various analyses. All of its wire is certified as to analysis and mechanical properties and conforms to A.I.S.I. specifications. It further is warranted by Western Wire.

* * *

A price list and data sheet is available upon request to the Western Wire Corporation.

Sunbeam Buys Mern Industries

Sunbeam Equipment Corporation, Meadville, Pa., has acquired **Mern Industries,** Oconomowoc, Wis., manufacturer of heat treating furnaces and equipment. Purchase included all engineering, patent rights and plant equipment. The operation will be integrated with the Sunbeam line of furnaces at Sunbeam headquarters in Meadville.

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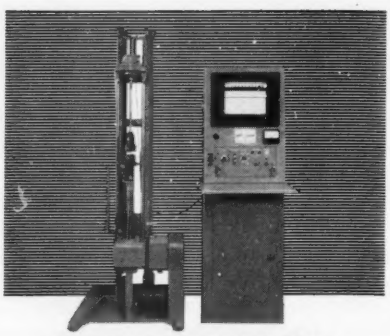
Bulletin on Silicones for Wire and Cable

A new eight-page, illustrated technical bulletin on silicone rubber for wire and cable insulation is available from the **Silicone Products Department** of **General Electric Co.**, Waterford, N.Y.

* * *

Designated S-4, the publication describes the various silicone rubber compounds now available for use as wire and cable insulation. In addition to tables showing typical properties of silicone rubber available to the wire and cable industry and suggestions for handling compounds, the publication is also illustrated with photos and art showing typical silicone rubber and wire and cable constructions and applications. An added feature is a section devoted to a discussion of silicone rubber gums which are available for fabricator mixing.



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Bulletin on Magnetic Drives

Louis Allis Co., Milwaukee, recently released Bulletin No. 3650 on Magnetic Adjustable Speed Drives.

* * *

Available in ratings from 50 through 2500 HP, the Magnetic Drive can be applied in many varied applications including Draw Benches, Extruders, Wire Drawing Machinery, Calenders, Pumps

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The Bulletin describes in detail the basic components of the Magnetic Drive, theory of operation, controls and design features. Some of the features of the unit include stationary field coil construction, liquid or air cooled clutch system and an AC Tachometer Generator.

* * *

Controls supplied for the drive are available in the standard Electronic Controller as well as the optional Transistorized Controller.

* * *

For more information write Department P, The Louis Allis Company, 427 E. Stewart, Milwaukee 1, Wis.

Signal Corps Wire & Cable Symposium

The tenth annual Wire and Cable Symposium, sponsored jointly by the **U. S. Army Signal Research and Development Laboratory** and industry, will be held at the Berkeley-Carteret Hotel, Asbury Park, N. J., on Nov. 29 and 30, and Dec. 1.

* * *

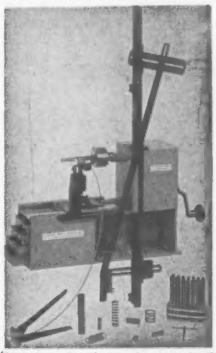
Some 25 technical papers pertinent to the Wire and Cable field will be presented. They will point out progress in various phases of the important field of communication wires and cables.

Davis-Standard Announces New Purchase Plans

Davis-Standard Div. of **Franklin Research & Development Corp.,** 14 Water St., Mystic, Conn., has issued a folder describing new time-payment and leasing plans that are available to customers.

* * *

Schedules of leasing and pay-as-you-produce costs are given to permit prospective customers to do a little figuring of their own when contemplating capital investments in extrusion and accessory equipment. The final page of the brochure is an application for financing or lease of purchases under consideration. Copies are available upon request to Davis-Standard.



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Bulletin Describes Screen Tensioners

Wedgtite tensioners for cloth and plate deck Allis-Chalmers screens are described in a new bulletin.

* * *

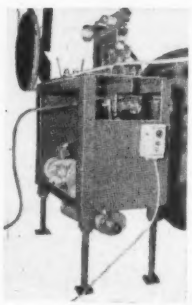
Designed to provide full takeup without changing bolt length, the Wedgtite tensioners eliminate tedious threading and bolt-cutting and reduce downtime. They can be adjusted — 1 1/4 inch take-up on each side and 2 1/2 inches overall — while the screen is running.

* * *

Complete instructions on how to apply the Wedgtite tensioners are given in the bulletin along with illustrations of the necessary components.

* * *

Copies of "New Wedgtite Tensioners," 26B9995, are available on request from Allis-Chalmers, Milwaukee 1, Wisconsin.



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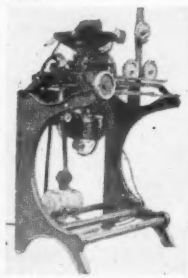

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Controling Quality of the Surface of Wire by Nondestructive Tests

(*Continued from page* 1397)

having these".

Fig. 17 — Pitted area of shot peened valve spring, manufactured from .187" diameter wire containing pits rejected by Magnatest flaw detector. Original magnification 15X — unetched.

Photo: Courtesy of Associated Spring Corporation.

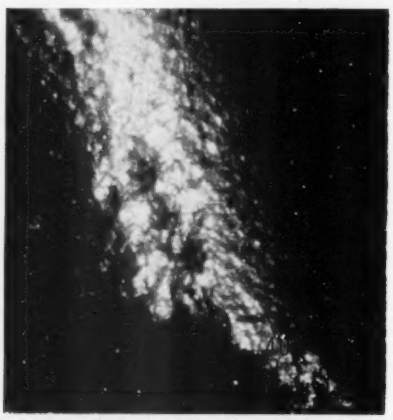

Fig. 18 — Illustration of fatigue fracture originating at pitted area of shot peened valve spring made from .187" diameter wire containing pits rejected by Magnatest flaw detector. Magnification 15X — unetched.

Photo: Courtesy of Associated Spring Corporation.

Fatigue test, run on springs made from rejected sections of wire, showed them to have a seriously reduced service life! One of these pits caused failure after 500,000 cycles, the other after 1,000,000 cycles in a laboratory fatigue test. These were automotive valve springs and, had they been installed in a car, would possibly have caused failure within the first few thousand miles of operation.

Summary

In conclusion we can say that

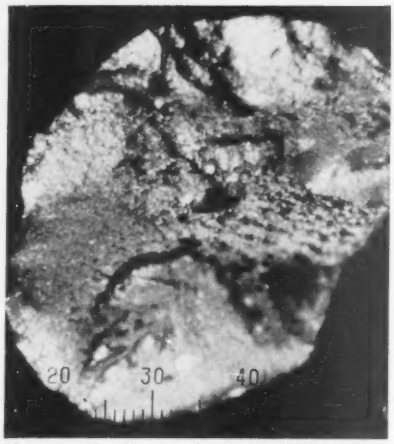

Fig. 19 — Fracture surface of fatigued spring shown in C. Fracture origin and pit are at left. Magnification 15X — unetched.

Photo: Courtesy of Associated Spring Corporation.

it is now practical and economically possible to control the quality of the surface of wire by nondestructive tests. The inspection of billets with fluorescent magnetic particles permits the steel mill to maintain consistent quality levels in respect to seams. The detection of seams, coupled with an approximate measurement of their depth, makes for more efficient and economical billet conditioning.

* * *

Seams in the finished wire, together with pits, nicks and slivers, can be detected electronically at speeds up to 500 ft. per minute and the defective areas marked for later removal.

* * *

Though these results are significant, the total work done in the industry to date is comparatively small. Much remains to be accomplished, in both billets and wire testing, and there is a need for us all to work together, if we are to realize the benefits promised by what we have seen.

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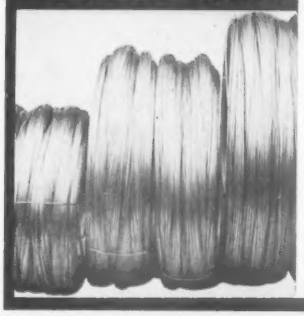

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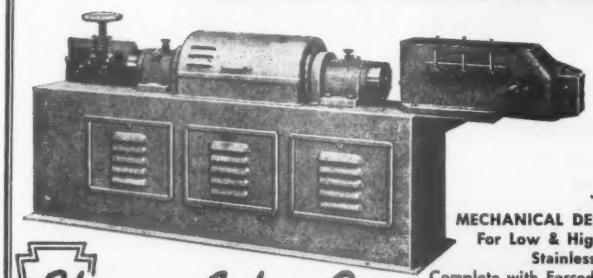

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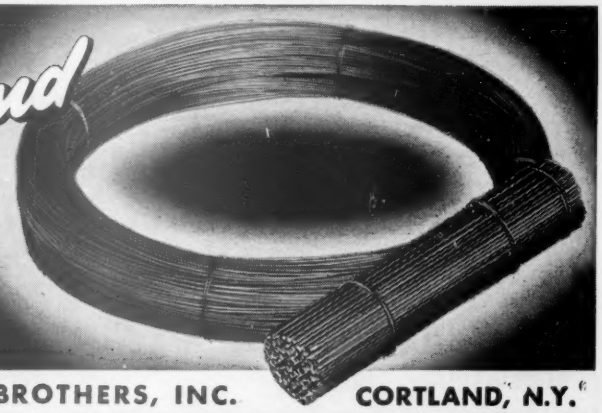

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Wire Coating with Polyethylene Resins: Improvement in Extrudate Quality by Using Sensitive Instrumentation

(*Continued from page* 1344)

tion problems. However, where heavy coatings are being applied at high output rates, an investment in a metering screw of recent design may give a high return in terms of extrusion of a quality melt at maximum rates.

Examples of Applications

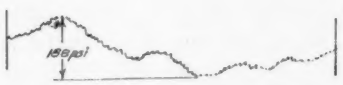
Sensitive instruments have been used a number of times to diagnose wire coating problems which occurred in commercial production. This type of "trouble shooting" provided useful information in minimum time that might have been impossible to obtain otherwise. All that is needed for installation is a 110 volt electrical connection, a hole drilled in the crosshead for a standard stock thermocouple and a source of cooling water for the 'Dynisco' gauge. Only a slight interruption in operation is needed to install the pressure gauge and/or thermocouple.

A typical example from a commercial operation indicates how the instruments may be used to observe variations in extrudate quality resulting from on-the-spot changes in processing variables. In producing a telephone conductor construction, 8 mils of polyethylene were extruded on a #24 AWG solid copper wire. With a speed capability of 1900 ft/min., the maximum rate at which smooth coatings could be produced was 600 ft/min. The wire coating line was equipped with a 2½" extruder, a design which is often used for high coating rates and normally gives excellent results.

* * *

The initial run was made under conditions set by the operator as standard. A long range pressure variation was obtained, amounting to 300 psi and extending over a 3½ minute period. The average short range pressure change was 50 psi. With the instruments installed, we were able to analyze quickly which processing variables should be changed. The long range variation decreased to 50 psi and the average short range to 25 psi, with a total head pressure of 1500 to 1600 psi. Results of changes in stock temperature, screw cooling, extruder settings, and resin color are illustrated in Figures 19, 20, and 21. Temperature variation was negligible and is not included.

Run #1: Initial Run



Run #2: Stock Temperature Raised From 415°F to 440°F

Figure 19. Pressure Variation on 2-1/2" Extruder.

The reduction in pressure variation was substantial. Has this been a heavier construction, the resulting improvement in caliper control would have been even more apparent. A 15% increase in the speed at which smooth coatings

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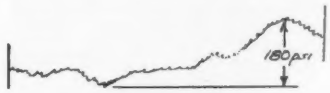
Run #3: Stock Temperature Increased From 450°F to 490°F

Run #4: Screw Cooling From 120°F to 100°F

Figure 20. Pressure Variation in 2-1/2" Extruder.

Run #5: Changed From White to Green Polyethylene



Run #6: Changed From Low Rear Barrel to Level Temperature Profile

Run #7: Changed to Lower Rear Barrel Temperature

Figure 21. Pressure Variation in 2-1/2" Extruder.

could be produced was also observed. Since the coating speed was still well below that desired, however, it was deduced that variables other than extrudate quality were responsible. This was subsequently proved to be correct. In addition to the incremental production rate improvement obtained immediately, the instruments indirectly assisted in a complete solution to the problem. The processor was able to isolate certain contributory variables and to concentrate on the primary causes.

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4. "Extruder Instrumentation", Kesler, Bonner, Squires, Wolf, SPE JOURNAL, *16*, 267 (March, 1960).
5. "Stock Thermocouples, Pressure Gauges, and Rupture Discs", Bernhardt, SPE JOURNAL, November, 1955.
6. Baldwin SR-4 gauges are made by Baldwin-Lima-Hamilton Corporation, Waltham, Massachusetts.
7. 'Dynisco' gauges are made by Dynamic Instruments Company, Cambridge, Massachusetts.
8. "Temperature Control in Extruder Barrels", Harold Ramsey, SPE JOURNAL, *16*, 1111-1113 (1960).

Activities Conducted Under NEMA Auspices

It is appropriate on this occasion for the National Electrical Manufacturers Association to reaffirm the following basic principles which govern all activities sponsored by the Association:

1. The activities of NEMA shall continue to be conducted pursuant to written policies and principles for the guidance of members and staff alike, and continued membership in NEMA is predicated upon acceptance and support of these policies and principles. These policies set forth the proper limits of such appropriate functions as standardization, the collection and dissemination of statistics, and business development and promotion.
2. All NEMA meetings shall continue to be limited to those occasions where legitimate and worthwhile objectives justify a coming together to discuss and act upon legal and proper problems. No other form of gathering or meeting is sanctioned or sponsored by NEMA.
3. Each such meeting shall continue to be held pursuant to a written agenda and is to be conducted in the presence of a staff representative of the Association, whose responsibility it is to keep full and complete minutes of all discussion and decisions. Such minutes are kept on file in a proper place and are available to any properly interested person.
4. Discussions of such commercial policies and practices as prices, terms and conditions of sale shall continue to be prohibited at such meetings.

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STATEMENT required by the Act of August 24, 1912, as amended by the Acts of March 3, 1933, and July 2, 1946 (Title 39, United States Code, Section 233) showing the ownership, management, and circulation of WIRE AND WIRE PRODUCTS, published monthly at Guilford, Conn. Conn., for year, 1961.

1. The names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher, Richard E. Brown, 453 Main Street, Stamford, Conn.; Editor, Edmund D. Sickles, 453 Main Street, Stamford, Conn.; managing editor, none; business manager, Ruth S. Spengel, 453 Main Street, Stamford, Conn.

2. The owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding 1 percent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a partnership or other unincorporated firm, its name and address, as well as that of each individual member, must be given.) Quinn-Brown Publishing Corporation, 453 Main Street, Stamford, Conn.; Richard E. Brown, 453 Main Street, Stamford, Conn.; Leta B. Brown, 1424 Almeda Padre Serra, Santa Barbara, Cal.; Ruth S. Spengel, 453 Main Street, Stamford, Conn.

3. The known bondholders, mortgagees, and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.) None.

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5. The average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the 12 months preceding the date shown above was: (This information is required from daily, weekly, semi-weekly, and tri-weekly newspapers only.)

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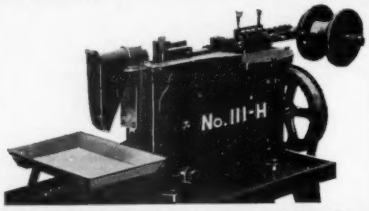

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William F. Ochs, 71, District Sales Manager of Cargotainer Division, **Tri-State Engineering Company,** Washington, Penna., and its associate, Wire-Tex **Corporation,** died suddenly August 10 at his home in Pittsburgh, Penna. He was one of the original developers and promoters of the welded wire container, Cargotainer, and saw this product grow from a small, initial order to a thriving industry. Mr. Ochs had been associated with Tri-State Engineering for twenty years and was active in materials handling affairs during that period.

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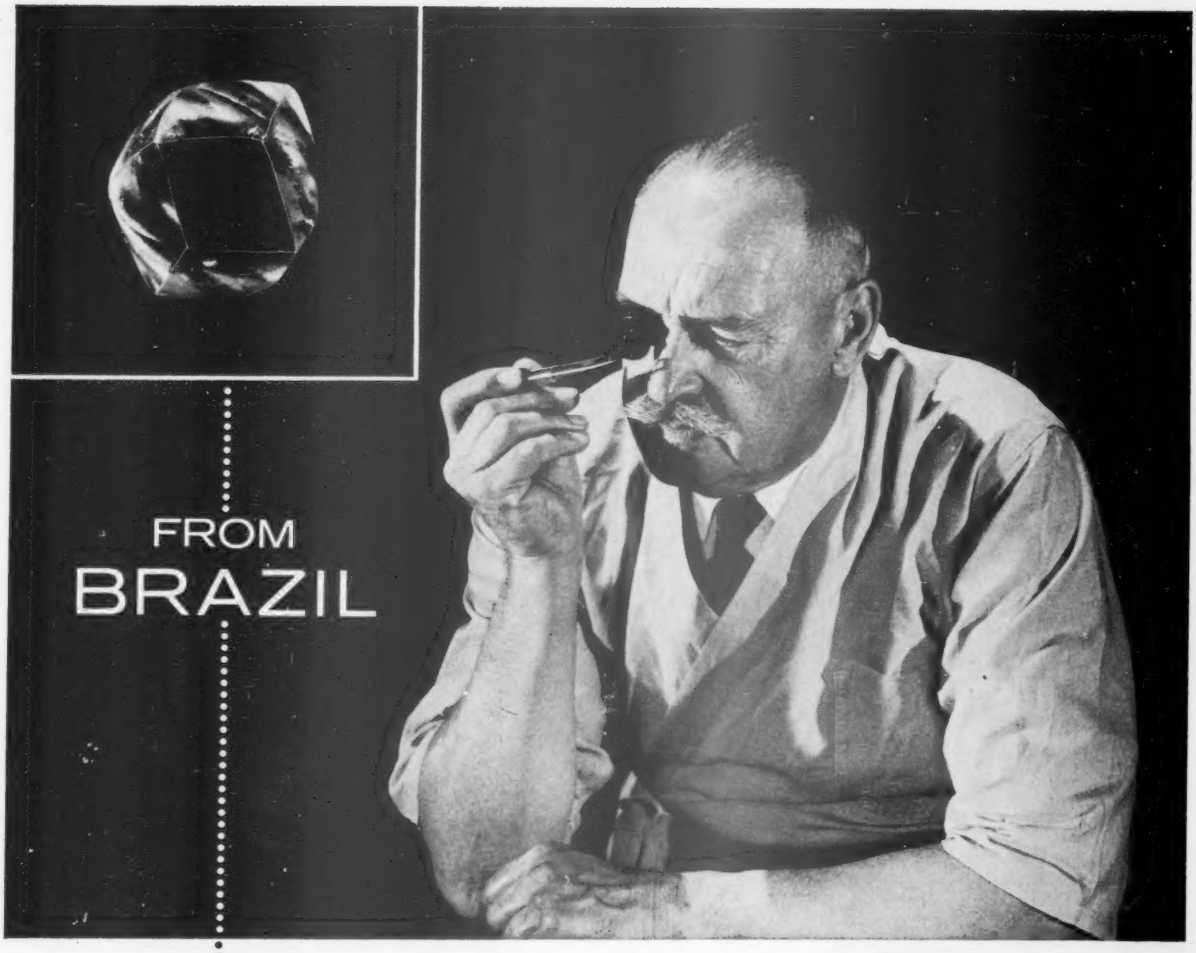

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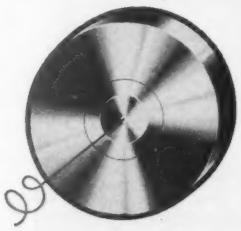

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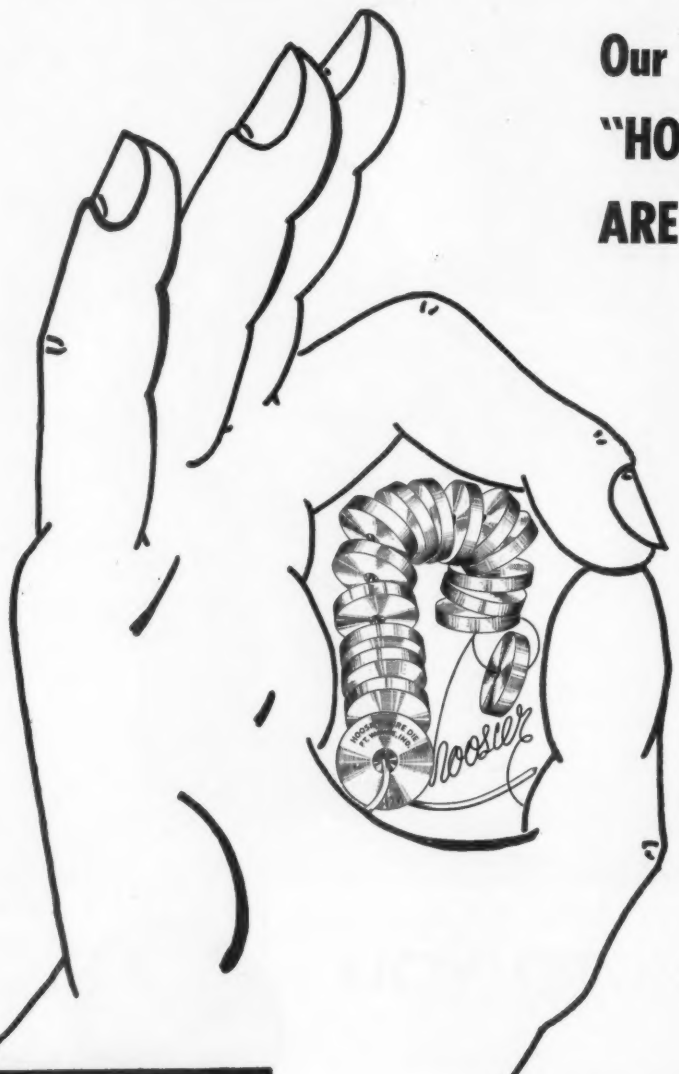

Astronaut Alan B. Shepard injected a new superlative into our language when he reported from space that everything was "A-Okay" . . . That's what our customers say about Hoosier dies—they're better than just Okay!

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Green "Alodized" Aluminum Chain Link Fence

Chain link fencing for outdoor transformer and switchgear installations in suburban areas can now be genuinely attractive as well as completely protective, according to the **Chain Link Fence Company** of Pennsylvania and **Amchem Products, Inc.**, of Ambler, Pa.

* * *

Plain untreated aluminum chain link fence, in general use since about 1955, has gained wide acceptance over conventional galvanized steel chain link fence because of its superior corrosion resistance. As is well known, galvanized steel will begin to rust in a matter of months in industrial areas, and requires periodic painting even in residential areas.

* * *

Even aluminum chain link fence, made of strong "6061" alloy (1.0% magnesium, 0.6% silicon, 0.25% chromium and 0.25% copper) will "oxidize" and become stained or pitted under certain conditions.

* * *

Amchem Products' "Alodine" appears to be the answer to the problem of long-lasting, low-maintenance aluminum chain link fencing. Alodine for this application is an amorphous phosphate-chromate which reacts chemically with aluminum to form a hard, thin coating which becomes an integral part of the metal, giving it a permanent light-green color as well as an extremely high degree of corrosion resistance—considerably higher than aluminum's good "natural" corrosion resistance. Alodizing is done at the factory after weaving of the fence "cloth," under carefully controlled conditions.

New Plastic Printing Service

Manger Electric Co., Inc., No. State St., Stamford, Conn. announces new services available: two-sided printing and circumferential printing of plastic sleeving. The ink coding equipment was purchased from the **Brand-Rex Division** of American Enka Corp. Additional equipment was also obtained to expand wire-stripping facilities.

* * *

Manger now offers center-stripping, miniature terminating, miniature wire stripping, counter-stripping, circumferential printing, and a new wire and cable identification system coded and carded for customer requirements.

Special Folder Covers Nickel-Base Alloys

The complete line of copper-base, stainless steel and nickel-base alloys produced by **Riverside-Alloy Metal Division**, H. K. Porter Company, Inc., has been described in a file folder, now available.

* * *

All information is arranged in an easy-to-read chart, printed directly on the file folder. The chart includes the alloys available, forms produced, outstanding characteristics of each alloy and several typical uses.

* * *

Also included is a unique evaluation chart, which invites users to maintain a permanent record of the performance of each alloy tested. The chart has sections to show exactly how the metal was used, as well as the comments of the department head actually utilizing it.

* * *

Copies of the new Porter Alloyist "filer" are available upon request by writing: The Alloyist,

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Riverside-Alloy Metal Division, H. K. Porter Company, Inc., Riverside, N. J.

100%-200% Increase in Volume Resistivity Features New Blane Color Concentrate Line

A new series of vinyl color concentrates with marked improvements in electrical properties has just been introduced by **The Blane Corporation,** Canton, Mass., manufacturers of vinyl and polyethylene compounds and color concentrates. This new "E" series of electrical grade concentrates are particularly suited for 60°C T and TW and 75°C THW applications.

* * *

The result of extensive research and development, the new series of color concentrates boasts of a 100 to 200 per cent increase in volume resistivity, while at the same time maintaining even color dispersion. The concentrates give rapid and full dispersion under heat and yield maximum color power per pound. In addition, they have proven to be excellent for heat stability and light fastness.

* * *

Further information on the New "E" Series of Color Concentrates may be obtained by writing directly to The Blane Corporation, Canton, Mass.

1961 List of ASTM Publications Now Available

The 62-page list of ASTM publications for 1961 is now available. This list, which has been mailed to all members, describes the symposiums, manuals, special publications, indexes, compilation of standards, charts, reference photographs, and reports published by the Society through the years. More than 300 items are fully described, 40 of which are new and not previously listed.

* * *

The publications are arranged conveniently by title and subject. A convenient order blank is included. The list may be obtained free for the asking from Society Headquarters at 1916 Race St., Philadelphia 3, Pa.

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Norton Issues New Catalog on Diamond Wheels & Hones

A new catalog of diamond wheels and diamond hones has been published by **Norton Company.** The catalog contains general information on diamond wheels, recommended starting specifications for a wide variety of work, prices, and a section of wheels for silicon and germanium cutting.

* * *

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Editor's Note

As we go to press, we have learned with great regret of the sudden passing of *Harold Rigby*, Director of *John Rigby & Sons Ltd.*, Bradford, England. He was a brother of *John Rigby*, Managing Director of the firm. He was well known to a great many of our friends in the United States.

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Index to Advertisers

A

A. & B. Tubing and Bar Stock Fixtures, Inc. ..... 1483 and 1484
Acrometal Products, Inc. ..... 1325, 1326, 1327 and 1328
Addison Electric, Muirhead Instruments, Inc. 1423
Ajax Industrial Supplies, Inc. 1473
Ajax Manufacturing Company, The 1256
Alabama Wire Die Co. ..... 1471 and 1473
Allis, Louis, Company, The 1207
Amchem Products, Inc. ..... 1290 and 1291
American Chain & Cable Company, Inc.
Page Steel & Wire Division 1242
American Insulating Machinery Company ..... 1372 and 1373
American Lanolin Corp. 1456
American Laubscher Corporation — Schumag 1294
American Machinery Co., Inc. 1465
Amplex Corporation, The 1244
Anaconda American Brass Company 1463
Antrim Reel, Inc. 1466
Apco Mossberg Company 1302
Apex Alkali Products Co. ..... 1381 and 1382
Armco Steel Corp., Sheffield Division 1265
Avery Baird Company 1454

B

Balloffet-Vianney Wire Die Co., Inc. 1468
Bartell-Machine Tool Corp. 1263
Bawden, William D. 1474
Bekaert Steel Wire Corporation 1347
Bemol 1458
Bethlehem Steel Company 1247
Blane Corporation, The 1206
Boonton Molding Co. 1441
Boulin, Victor J., Inc. 1473
Breitenbach, Wilhelm 1214
Brenon, Inc. 1473
Bridge Manufacturing Company ..... 1212 and 1213

C

Camden Wire Co., Inc. 1456
Canadian Vickers Limited 1234
Carl Mayer Corp., The 1262
Carlson Company, The 1465
Carlton Manufacturing Co. 1474
Cary Chemicals Inc. 1309
Carris Reels, Inc. 1469
Central Tool & Machine Company, Wire Tool Division 1457
Chadwick Yarn Company 1465
Chemical Products Corporation 1298
Chesney Tool & Engineering Corp. 1447
Circle Chemical Company 1465
Clark, J. L., Manufacturing Co. ..... 1352 and 1353
Cleveland Tramrail Division of
The Cleveland Crane & Engineering Co. ..... 1274 and 1275
Climax Molybdenum Company, a division of
American Metal Climax, Inc. 1266
Colbourne Machine Company ..... 1474 and 1475
Colorado Fuel & Iron Corporation, The ..... 1390 and 1391
Continental Steel Corporation 1426
Cooke Color & Chemical Co. 1211
Cook Manufacturing Co. 1240
Coulter & McKenzie Machine Co., The ..... Inside Front Cover

D

Danforth C. W., Co., The 1470
Davis Electric Co. 1243
Davis Standard Division of Franklin Research
and Development Corporation ..... 1257, 1258, 1259 and 1260
Detroit Steel Corporation 1384
Dewyer, Inc. 1466
Dow Corning Corporation ..... 1386 and 1387
Durant Manufacturing Co. 1453
Durkee Manufacturing Co., Inc. 1210

E

Eastern Carbide Corp. 1469
Eastern Engineering Co. 1443
Eaton Manufacturing Company, Reliance Division 1223
Edmands Co., The 1453
Eisler Engineering Co., Inc. 1470
Electro Metals Separation Co., Div. of M. J. Stavola Co., Inc. 1474
Elgin National Watch Company, Abrasives Division 1408
Emory, Robert J., Company 1238
Engis Equipment Co., Hyprez Division 1461
Entwistle Manufacturing Corporation 1425
E V G — Richard E. Kleinhans 1444

F

Federal Manufacturing Co., The 1267
Fenn Manufacturing Company, The 1251
Firth Sterling, Inc. 1272
Fisher Associates 1450
Fort Wayne Diamond Products, Inc. 1473
Fort Wayne Wire Die, Inc. 1473

G

Gavlick Machinery Corporation 1458
Gem Gravure Company, Inc. 1429
Gillies, Duncan M., Co., Inc. 1421
Glader, Wm., Machine Works 1428
Glader, Wm., Machine Works, Export Department 1451
Goodrich-Gulf Chemicals, Inc. ..... 1236 and 1237

H

Haskell-Dawes Machine Co., Inc. 1457
Heany Industrial Ceramic Corp. 1315
Heil Process Equipment Corporation 1455
Herborn Machinery Corp. ..... 1358 and 1359
Hoosier Wire Die, Inc. 1472
Hubbard Spool Division, Van Norman Industries, Inc. 1318
Hudson Wire Company 1286
Hutten-und Bergwerke Rheinhausen, AG 1431

I

Indiana Wire Die Co. ..... 1471 and 1473
Interlocking Fence Co. 1440
Ironsides Company, The 1454

J

Jersey Specialty Co., Inc. 1464
Johnson Machinery Company 1474
Johnson Steel & Wire Company, Inc. ..... 1300 and 1301

K

Kelloy Corporation 1295
Kelly Wire Die Corporation 1473
Kenner, Paul I. Co. 1446
Kenrich Petrochemicals, Inc. 1311
Keystone Steel & Wire Company 1221
Krupp, Fried., Maschinen-und Stahlbau ..... 1218 and 1219

L

Laclede Steel Company 1270
Laribee Wire, Inc. 1377
Larmuth (1947) Ltd. 1459
Lewis Machine Company, The 1253
Loma Machine Mfg. Co., Inc. 1432
Ludlow Papers, Division of Ludlow Corporation 1229

M

Magnaflux Corporation 1241
Magnuson Products Corporation 1459
Malin & Company, The 1466
Manco Mfg. Co. 1287
McCaskie, Wm., Inc. 1430
Merrimac Spool & Reel Co., Inc. 1466
Metal & Thermit Corporation 1222
Metallurgical Products Department
General Electric Company 1226

Mettler Machine Tool, Inc. 1312
MH Machines, Morgardshammar Mek Verstads, AB ..... 1230 and 1231
Micro Products Co. 1345
Miller, R. H., Company, Inc. 1320
Miyazaki Iron Works, Ltd. 1261
Monsanto Chemical Company, Plastics Division 1250
Montgomery Company, The 1280
Morgan Construction Co. ..... 1400 and 1401
Morris, Robert E., Company, Rem Sales Incorporated Div. ..... 1434 and 1435
Mossberg Pressed Steel Corporation Division of Wanskuck Co. 1308
Muirhead Instruments, Inc., Addison Electric Division 1423

N

National Machinery Co. 1461
National Machinery Exchange 1474
National Wire Die Co., Inc. 1306
Neff, J. W., Laboratories, Inc. 1468
Nelson Company, The 1474
New England Butt Co., Division of Wanskuck Company ..... 1248 and 1249
New England Wire Die Co. 1473
Nichols Wire & Aluminum Co. 1305
Nippon Stainless Steel Wire Mfg. Co., Ltd. 1467
Norcross Corporation 1464
Northern Indiana Steel Supply Co., Inc. 1276
North Waterford Spool Company 1464
Norton, Sir James Farmer, & Co., Ltd. ..... 1268 and 1269

O

Ofenbau, Fritz, G.m.b.H. 1445
Olsen, Tinius, Testing Machine Company 1332
Orban, Kurt, Company, Inc., Niederrheinische Hutte AG 1224
Orban, Kurt, Company, Inc. 1273

P

Page Steel and Wire Division American Chain & Cable Company, Inc. 1242
Pan American Supply Company 1288
Pangborn Corporation 1296
Parkin Chemical Company 1452
Patterson, Geo. C., Machine Company, The 1225
Pittsburgh Carbide Die Co. 1473
Pittsburgh Chemical Co. 1215
Pittsburgh Steel Company ..... 1316 and 1317
Plastic Mold and Engineering Co. 1455
Platt Bros. & Co., The 1474
Polymel Corporation, The 1304
Porter, H. K., Inc. 1449
Pourtier Pere et Fils 1444
Prutton Corporation 1424

R

Reicher Paul, Machinery and Equipment Ltd., H. A. Schlatter, Ltd. 1292
Republic Steel Corporation ..... 1254 and 1255
Richards, J. A., Company 1436
Robinson, M. W., Co., Inc. 1209
Roebling's, John A., Sons Div., The Colorado Fuel & Iron Corp. 1239
Roux Wire Die Works, Inc. 1462
Royle, John & Sons 1303
Rusch Wire Die Corporation 1473
Rylands Brothers, Limited 1216

S

S A M P, Emilio Wartenweiler 1277
Sancliff, Inc. 1462
Schlatter, H. A., Ltd., Paul Reicher Machinery and Equipment, Ltd. 1292
Scott Testers, Inc. 1464
Scovill Manufacturing Company 1282
Scudder, E. J., Foundry & Machine Co. 1474
Seybold Transworld Exporters — Downey Bale Tie 1451
Seybold Transworld Exporters — Humphrey & Sons Co. 1451
Sheffield Division, Armco Steel Corp. 1265
Showa Machine Works, Ltd. 1279
Sjogren Tool & Machine Co., Inc. 1208
Societa Generale Delle Macchine Mill 1264
Southwire Company 1289
Stamford Processing Co. 1474
Stanat Manufacturing Co., Inc. 1278
Standard Electronics Research Corp. 1283
Standard Industrial Compounds Co., Inc. 1205
Standard Mill Supply Company 1438
Steel Equipment Company 1235
Steele, M. G., Co. 1470
Steel and Wire Machinery Company 1252
Straus-Artys Corp. — Malmedie 1433
Straus-Artys — Salvi 1467
Sumitomo Metal Industries Ltd. 1227
Superior Tool & Manufacturing Co. 1468
Syncro Machine Company ..... 1336 and 1337 and Back Cover
Synthetic Thread Co. 1467

T

Tanisaka Iron Works Ltd. 1448
Tensitron, Inc. 1474
Titan Metal Manufacturing Company 1233
Torrington Manufacturing Company 1299
Twitchell, E. W., Inc. 1427

U

Union Carbide Plastics Company, Division of Union Carbide Corporation 1313
Union Wire Die Corp. 1293
U. S. Borax 1460
Unitech Products, Inc. 1437
Universal Industrial Equipment Co. 1232

V

Van Norman Industries Inc., Hubbard Spool Division 1318
Vaughn Machinery Company, The ..... Front Cover and 1361, 1362, 1363 and 1364
Volco Brass & Copper Co. 1460

W

Waflos Machinery Corp. ..... 1284 and 1285
Walco Electric Company 1228
Wardwell Braiding Machine Co. 1246
Wartenweiler, Emilio, S A M P 1277
Watkins, R. S., & Sons, Inc. 1310
Watson Machine Company, The ..... Inside Back Cover
Wayne Wire Die Co. 1470
Wells, Frank L., Company 1439
Wesche, B. A., Electric Co., The 1452
Western Wire Corporation 1245
Western Wire & Textile Machinery, Inc. 1446
Wheelabrator Corporation 1281
Whitacre Corporation 1217
Wichita Wire Products Company, Inc. 1450
Wickwire Brothers, Inc. 1467
Wilson, Lee, Engineering Co., Inc. 1271
Wirecrafters, Inc. 1307
Wire Engineering Associates, Inc. 1297
Wire Machinery, Inc. 1410
Wire & Textile Machinery Inc. 1422
Worcester Automatic Machine Company 1442

Y

Yawata Iron & Steel Co., Ltd. 1314

WHERE TO BUY

For more complete information, consult the annual Wire and Wire Products Buyer's Guide. Advertisers who have contracted for 6 or more insertions are entitled to up to 8 listings in this section of Wire and Wire Products.

ABRASIVES—
Alabama Wire Die Co., Fayette, Ala.
Elgin National Watch Co., Abrasives Div., Elgin, Ill.
Hyprez Div., Engis Equipment Co., Chicago, Ill.
Indiana Wire Die Co., Ft. Wayne, Ind.
Pangborn Corporation, Hagerstown, Md.
Wheelabrator Corporation, Mishawaka, Ind.

ABRASIVES— Shot & Grit, For Cleaning
Pangborn Corporation, Hagerstown, Md.
Wheelabrator Corporation, Mishawaka, Ind.

ACID INHIBITORS—
(See Inhibitors, Pickling)

ANNEALING MACHINES — Electric Resistance
Syncro Machine Co., Perth Amboy, N. J.
Walco Electric Co., Providence, R. I.

ANNEALING POTS AND BOXES—
Scudder, E. J., Fdry. & Mach. Co., Trenton, N. J.

BAKERS—
(See OVENS—Rod Bakers)

BAR—Steel
Eaton Mfg. Co., Massillon, Ohio

BOBBINS—Braider & Wire Weaving
Acrometal Products, Inc., Minneapolis, Minn.
Apco Mossberg Co., Attleboro, Mass.
Mossberg Pressed Steel Corp., Division of Wanskuck Co., Attleboro, Mass.
Plastic Mold & Engineering Co., Providence, R. I.
Standard Mill Supply Co., Pawtucket, R. I.
Wardwell Braiding Machine Co., Central Falls, R. I.
Western Wire & Textile Machinery, Inc., So. San Francisco, Calif.

BORAX—Wire Drawing
U. S. Borax, New York, N. Y.

BRAZERS—Electric for Wire
Steele Company, M. G., Rome, N. Y.

CABLE ACCESSORIES
Southwire Co., Carrollton, Ga.

CABLE—Electric
Laribee Wire Inc., Camden, N. Y.
Southwire Co., Carrollton, Ga.

CABLE FILLERS—Paper
Ludlow Corporation, Needham Heights, Mass.
Twitchell, Inc., E. W., Philadelphia, Pa.

CAPSTANS—for Wire (also Caterpiller Types)
Bartell Machine Tool Corp., Rome, N. Y.
Colbourne Machine Company, Winsted, Conn.
Coulter & McKenzie Machine Co., Bridgeport, Conn.
Davis Electric Co., Wallingford, Conn.
Davis-Standard Div. of Franklin Research and Development Corp., Mystic, Conn.
Entwistle Manufacturing Corporation, Providence, R. I.
Federal Manufacturing Company, Wallingford, Conn.
General Engineering (Radcliffe) Co., Ltd., Manchester, England

CARRIERS—Braider, High Speed
Apco Mossberg Co., Attleboro, Mass.
Mossberg Pressed Steel Corp., Division of Wanskuck Co., Attleboro, Mass.
New England Butt Co., Division of Wanskuck Co., Providence, R. I.
Wardwell Braiding Machine Co., Central Falls, R. I.
Western Wire & Textile Machinery, Inc., So. San Francisco, Calif.

CASTINGS—Wire Mill
Scudder, E. J. Fdry. & Mach. Co., Trenton, N. J.

CEMENTS—Refractory
Amchem Products, Inc., Ambler, Pa.

CLEANERS—Metal
Amchem Products, Inc., Ambler, Pa.
Apex Alkali Products Co., Phila., Pa.
Circle Chemical Co., Chicago, Ill.
Magnuson Products Corporation, Brooklyn, N. Y.
Miller, R. H., Co., Inc., Homer, N. Y.
Parkin Chemical Co., The, Pittsburgh, Pa.
Standard Industrial Compounds Co., Frankfort, Ill.

CLEANING & PICKLING EQUIP.—
Cleveland Tramrail Div., of the Cleveland Crane & Engineering Co., Wickliffe, Ohio
Morgan Construction Co., Worcester, Mass.
Wheelabrator Corporation, Mishawaka, Ind.
Wilson, Lee, Engr. Co., Cleveland, Ohio

CLOTH—Wire, All Metals—
Wickwire Bros., Cortland, N. Y.

COATING COMPOUNDS—
Amchem Products, Inc., Ambler, Pa.
Apex Alkali Products Co., Philadelphia, Pa.
Chemical Products Corporation, E. Providence, R. I.
Magnuson Products Corp., Brooklyn, N. Y.
Miller, R. H., Co., Homer, N. Y.
Standard Industrial Compounds Co., Frankfort, Ill.
U. S. Borax, New York, N. Y.

COLOR CONCENTRATES—For Wire Coatings
Blane Corporation, The, Canton, Mass.

COMPOUNDS—Brazing
Steele Company, M. G., Rome, N. Y.

COMPOUNDS—Coppering
Amchem Products, Inc., Ambler, Pa.
Circle Chemical Co., Chicago, Ill.
Miller, R. H. Co., Inc., Homer, N. Y.

COMPOUNDS—Diamond (Pre-Mixed)
Alabama Wire Die Co., Fayette, Ala.
Eastern Carbide Corp., New Rochelle, N. Y.
Elgin National Watch Co., Abrasives Div., Elgin, Ill.
Hyprez Div., Engis Equipment Co., Chicago, Ill.
Indiana Wire Die Co., Ft. Wayne, Ind.
Rusch Wire Die Corp., Croton-on-Hudson, N. Y.

COMPOUNDS—Extrusion, for Wire
Amchem Products, Inc., Ambler, Pa.
Blane Corporation, The, Canton, Mass.
Circle Chemical Co., Chicago, Ill.
Monsanto Chemical Company, Plastics Division, Springfield, Mass.

COMPOUNDS—For Improving Drawing & Extrusion
Amchem Products, Inc., Ambler, Pa.
Circle Chemical Co., Chicago, Ill

COMPOUNDS—Metal Finishing
Amchem Products Inc., Ambler, Pa.
Apex Alkali Products Co., Philadelphia, Pa.
Chemical Products Corporation, E. Providence, R. I.
Circle Chemical Co., Chicago, Ill.

COMPOUNDS—Phosphate Coating
Amchem Products Inc., Ambler, Pa.
Circle Chemical Co., Chicago, Ill.

COMPOUNDS—Rust Preventing
Amchem Products, Inc., Ambler, Pa.
American Lanolin Corp., Lawrence, Mass.
Apex Alkali Products Co., Philadelphia, Pa.
Chemical Products Corporation, E. Providence, R. I.
Circle Chemical Co., Chicago, Ill.

COMPOUNDS—Rust Removing
Amchem Products, Inc., Ambler, Pa.
Apex Alkali Products Co., Philadelphia, Pa.
Magnuson Products Corp., Brooklyn, N. Y.
Standard Industrial Compounds Co., Frankfort, Ill.

COMPOUNDS—Vinyl
Blane Corporation, The, Canton, Mass.
Chemical Products Corporation, E. Providence, R. I.
Kenrich Petrochemicals, Inc., Maspeth, N. Y.
Monsanto Chemical Company, Plastics Division, Springfield, Mass.
Union Carbide Plastics Company, Div. of Union Carbide Corporation, New York, N. Y.

COMPOUNDS—Wire Drawing
Apex Alkali Products Co., Philadelphia, Pa.
Climax Molybdenum Co., Div., American Metal Climax, Inc., New York, N. Y.
Magnuson Products Corp., Brooklyn, N. Y.
Miller, R. H. Co., Inc., Homer, N. Y.
Standard Industrial Compounds Co., Frankfort, Ill.
Swift & Company, Chicago, Ill.
U. S. Borax, New York, N. Y.

CONDUCTORS—Flexible, Electrical
Laribee Wire Inc., Camden, N. Y.
Montgomery Co., The, Windsor Locks, Conn.

CONTAINERS—Wire Packaging
(See DRUMS—Wire Packaging)

CONTROL PANELS—
Walco Electric Co., Providence, R. I.

COPHOLDERS—Steel
Apco Mossberg Co., Attleboro, Mass.
Mossberg Pressed Steel Corp., Division of Wanskuck Co., Attleboro, Mass.
Wire & Textile Mach'y, Inc., (used), Pawtucket, R. I.

CORDS—Electrical, Tinsel Conductor
Montgomery Co., The, Windsor Locks, Conn.

COUNTERS—
(See MACHINERY—Measuring Wire and Cable)

CRANES—Wire Mill
Cleveland Tramrail Div. of the Cleveland Crane & Engineering Co., Wickliffe, Ohio
Morgan Construction Co., Worcester, Mass.

CUTTING TOOLS—Carbide
Eastern Carbide Corp., New Rochelle, N. Y.
Metallurgical Products Dept. of General Electric Co., Detroit, Mich.

CUTTING TOOLS—Wire
Manco Mfg. Co., Bradley, Ill.
Porter, H. K., Inc., Somerville, Mass.
Robinson, M. W. Co., Rockville, Conn.

DIAMONDS—Industrial
Alabama Wire Die Co., Fayette, Ala.
Balloffet-Vianney Wire Die Co., Inc., Guttenberg, N. J.
Indiana Wire Die Co., Ft. Wayne, Ind.
Rusch Wire Die Corp., Croton-on-Hudson, N. Y.
Wayne Wire Die Co., Linden, N. J.

DIAMOND POWDERS—
Danforth Company, C.W., Youngstown, Ohio
Elgin National Watch Co., Abrasives Div., Elgin, Ill.
Fort Wayne Diamond Products, Inc., Fort Wayne, Indiana
Hoosier Wire Die, Inc., Ft. Wayne, Ind.
Hyprez Div., Engis Equipment Co., Chicago, Ill.
Kelly Wire Die Corp., New York, N. Y.
New England Wire Die Co., Worcester, Mass.
Rusch Wire Die Corp., Croton-on-Hudson, N. Y.
Wayne Wire Die Co., Linden, N. J.

DIAMOND POWDER RECLAIMING—
Alabama Wire Die Co., Fayette, Ala.
Danforth Company, C.W., Youngstown, Ohio
Elgin National Watch Co., Abrasives Div., Elgin, Ill.
Fort Wayne Diamond Products, Inc., Fort Wayne, Indiana
Hoosier Wire Die, Inc., Ft. Wayne, Ind.
Indiana Wire Die Co., Ft. Wayne, Ind.
Kelly Wire Die Corp., New York, N. Y.
Rusch Wire Die Corp., Croton-on-Hudson, N. Y.

DIAMOND TOOLS—
Wayne Wire Die Co., Linden, N. J.

DIES—Carbide, Tungsten & Tantalum
Balloffet-Vianney Wire Die Co., Inc., Guttenberg, N. J.
Boulin, Victor J., Inc., New York, N. Y.
Eastern Carbide Corp., New Rochelle, N. Y.
Kelloy Corporation, New York, N. Y.
Kelly Wire Die Corp., New York, N. Y.
Metallurgical Products Dept. of General Electric Co., Detroit, Mich.
Rusch Wire Die Corp., Croton-on-Hudson, N. Y.
Wayne Wire Die Co., Linden, N. J.

DIES—Cold Heading
Eastern Carbide Corp., New Rochelle, N. Y.
Kelloy Corporation, New York, N. Y.
Metallurgical Products Dept. of General Electric Co., Detroit, Mich.

DIES—Diamond
Alabama Wire Die Co., Fayette, Ala.
Ajax Industrial Supplies, Inc., Ft. Wayne, Ind.
Balloffet-Vianney Wire Die Co., Inc., Guttenberg, N. J.
Boulin, Victor J. Inc., New York, N. Y.
Brenon, Inc., Nixon, N. J.
Ft. Wayne Wire Die Inc., Fort Wayne, Ind.
Hoosier Wire Die, Inc., Fort Wayne, Ind.
Indiana Wire Die Co., Fort Wayne, Ind.
Kelly Wire Die Corp., New York, N. Y.
National Wire Die Co., Inc., New York, N. Y.
New England Wire Die Co., Worcester, Mass.
Roux Wire Die Works, Inc., Oriskany, N. Y.
Rusch Wire Die Corp., Croton-on-Hudson, N. Y.
Wayne Wire Die Co., Linden, N. J.

DIES DIAMOND—Controlled Drawing Angle
Hoosier Wire Die, Inc., Fort Wayne, Ind.

DIES DIAMOND—Reversible
National Wire Die Co., Inc., New York, N. Y.

DIES—Extrusion
Alabama Wire Die Co., Fayette, Ala.
Central Tool and Machine Co., Bridgeport, Conn.
Eastern Carbide Corp., New Rochelle, N. Y.
Indiana Wire Die Co., Ft. Wayne, Ind.
Kelloy Corporation, New York, N. Y.
Metallurgical Products Dept. of General Electric Co., Detroit, Mich.

Rusch Wire Die Corp., Croton-on-Hudson, N.Y.
Wayne Wire Die Co., Linden, N. J.

DIES—Eyelet
Eastern Carbide Corp., New Rochelle, N. Y.
Kelloy Corporation, New York, N. Y.

DIES—Nail, Nail Cutters, Feeder Blocks, Grippers, etc.
Pittsburgh Carbide Die Co., Monongahela, Pa.

DIES—Pointing
Fenn Manufacturing Co., Newington, Conn.
Sjogren Tool & Machine Co., Auburn, Mass.

DIES—Repairs & Re-Cutting
Ajax Industrial Supplies, Inc., Fort Wayne, Ind.
Balloffet-Vianney Wire Die Co., Inc., Guttenberg, N. J.
Boulin, Victor J., Inc., New York, N. Y.
Brenon, Inc., Nixon, N. J.
Eastern Carbide Corp., New Rochelle, N. Y.
Ft. Wayne Wire Die, Inc., Fort Wayne, Ind.
Hoosier Wire Die, Inc., Ft. Wayne, Ind.
Kelly Wire Die Corp., New York, N. Y.
Metallurgical Products Dept. of General Electric Co., Detroit, Mich.
National Wire Die Co., Inc., New York, N. Y.
New England Wire Die Co., Worcester, Mass.
Roux Wire Die Works, Inc., Oriskany, N. Y.
Rusch Wire Die Corp., Croton-on-Hudson, N. Y.
Wayne Wire Die Co., Linden, N. J.

DIES—Special Shapes, Etc.
Eastern Carbide Corp., New Rochelle, N. Y.
Kelloy Corporation, New York, N. Y.

DIES—Swaging
Fenn Manufacturing Co., Newington, Conn.
Sjogren Tool & Mach. Co., Inc., Auburn, Mass.

DIES—Tinning
Roux Wire Die Works, Inc., Oriskany, N. Y.

DIES—Tube Drawing
Balloffet-Vianney Wire Die Co., Inc., Guttenberg, N. J.
Eastern Carbide Corp., New Rochelle, N. Y.
Hoosier Wire Die, Inc., Ft. Wayne, Ind.
Kelloy Corporation, New York, N. Y.
Kelly Wire Die Corp., New York, N. Y.
Metallurgical Products Dept. of General Electric Co., Detroit, Mich.
Rusch Wire Die Corp., Croton-on-Hudson, N. Y.

DRAW BENCHES—
(See MACHINERY—Draw Benches)

DRIVES—Variable Speed
Allis Co., Louis, Milwaukee, Wisc.
Walco Electric Co., Providence, R. I.

DRUMS—Wire Packaging
Hubbard Spool Company, Div., Van Norman Industries, Inc., Garrett, Ind.

DRUMS & TRAVERSES—For Cable Reels
Hubbard Spool Company, Div., Van Norman Industries, Inc., Garrett, Ind.
Republic Steel Corp., Berger Div., Canton, Ohio

DRYING EQUIPMENT—
Carl Mayer Corp., The, Cleveland, Ohio

DUST COLLECTORS—Wet or Dry
Pangborn Corporation, Hagerstown, Md.
Wheelabrator Corporation, Mishawaka, Ind.

ENGINEERS—Consulting
Bawden, William D., Wilton, Conn.

EYELETS—Brass or Zinc
Platt Bros. & Co., The, Waterbury, Conn.

FOAM PRODUCING COMPOUNDS—
Amchem Products, Inc., Ambler, Pa.
Chemical Products Corporation, E. Providence, R. I.
Parkin Chemical Co., The, Pittsburgh, Pa.

FURNACES—Annealing, Vacuum
American Laubscher Corporation, New York, N. Y.

FURNACES—Galvanizing Equipment
Ofenbau Fritz, G.m.b.H. & Co., K. G., Hagen, (W. Germany)
Wilson, Lee, Engr. Co., Cleveland, Ohio

FURNACES—Heat Treating
Carl Mayer Corp., The, Cleveland, Ohio
Ofenbau Fritz, G.m.b.H. & Co., K. G., Hagen, (W. Germany)
Wilson Lee Engr. Co., Cleveland, Ohio

FURNACES—Pot (Oil, Gas, Electric)
Ofenbau Fritz, G.m.b.H. & Co., K. G., Hagen, (W. Germany)

FURNACES—Strand Annealing
Ofenbau Fritz, G.m.b.H. & Co., K. G., Hagen, (W. Germany)

GALVANIZING EQUIPMENT—(See MACHINERY—Galvanizing Wire)

GUIDES—For Wire
Alabama Wire Die Co., Fayette, Ala.
Heany Industrial Ceramic Corp., New Haven, Conn.
Indiana Wire Die Co., Fort Wayne, Ind.

GUIDE TIPS—For Extruding Machines (See NOZZLES)

HAMMERS—Nail Heading
Pittsburgh Carbide Die Co., Monongahela, Pa.

HAMMERS—Swaging
Sjogren Tool & Machine Co., Auburn, Mass.

HOISTS—Electric
Cleveland Tramrail Div. of the Cleveland Crane & Engineering Co., Wickliffe, Ohio
Walco Electric Co., Providence, R. I.

INHIBITORS—Pickling
Amchem Products, Inc., Ambler, Pa.
Apex Alkali Products Co., Philadelphia, Pa
Parkin Chemical Co., The, Pittsburgh, Pa.

INKS—Printing, for Insulated Wire
Chemical Products Corporation, E. Providence, R. I.
Entwistle Manufacturing Corporation, Providence, R. I.
Gem Gravure Company, West Hanover, Mass.

INSULATING MATERIALS—
Blane Corporation, The, Canton, Mass.
Dow Corning Corporation, Midland, Mich.
General Electric Company, Insulating Materials Section, Schenectady, N. Y.
Kenrich Petrochemicals, Inc., Maspeth, N. Y.
Monsanto Chemical Company, Plastics Division, Springfield, Mass.

LACQUERNG SYSTEMS—See MACH.—Lacquering Electric Wire

LAME—LAHN—
Montgomery Co., The, Windsor Locks, Conn.

LUBRICANTS—For Metal Cutting, Stamping and Drawing
Apex Alkali Products Co., Philadelphia, Pa.
Millier, R. H., Co., Inc., Homer, N. Y.
Standard Industrial Compounds Co., Frankfort, Ill.

LUBRICANTS—Wire Drawing
(See Compounds—Wire Drawing)

LUBRICANTS—Wire Rope
Climax Molybdenum Co., Div., American Metal Climax, Inc., New York, N. Y.
Swift & Co., Chicago, Ill.

MACHINE CONTROLS—Electronic
Allis Co., Louis, Milwaukee, Wisc.

MACHINERY—Armoring (Cable, Wire, Hose)
Watson Machine Co., Paterson, N. J.
Western Wire & Textile Machinery, Inc., So. San Francisco, Calif.

MACHINERY—Assembling
Pan American Supply Co., Long Island City, N. Y.

MACHINERY—Barbed Wire
Glader Wm., Machine Works, Chicago, Ill.
Tanisaka Iron Works Ltd., Amagaski, Hyogo, Japan

MACHINERY—Blast Cleaning
Pangborn Corporation, Hagerstown, Md.
Wheelabrator Corporation, Mishawaka, Ind.

MACHINERY—Bolt, Rivet, Screw, etc.
Gavlick Machinery Corporation, Bridgeport, Conn.
National Machinery Co., Tiffin, Ohio
Prutton Corporation, Cleveland, Ohio
Straus-Artys Corp., Great Neck, N. Y.
Waterbury-Farrel Fdy. & Mach. Co., Inc., Div. of Textron, Inc., Waterbury, Conn.

MACHINERY—Braiding
New England Butt Co., Division of Wanskuck Co., Providence, R. I.
Wardwell Braiding Machine Co., Central Fall, R. I.
Wire & Textile Mach'y, Inc., (used), Pawtucket, R. I.

MACHINERY—Brazers for Wire
Steele Company, M. G., Rome, N. Y.

MACHINERY—Bunching
Cook Mfg. Co., The, Paterson, N. J.
Edmands Company, The, Cranston, R. I.
Haskell-Dawes Machine Co., Philadelphia, Pa.
Miyazaki Iron Works, Ltd., Osaka, Japan
New England Butt Co., Division of Wanskuck Co., Providence, R. I.
Niehaus K. A. Maschinenfabrik, Dusseldorf-Rath, Germany
Watson Machine Co., Paterson, N. J.
Western Wire & Textile Machinery, Inc., So. San Francisco, Calif.
Wire & Textile Mach'y, Inc., (used), Pawtucket, R. I.

MACHINERY—Cable, Electric
Cook Mfg. Co., The, Paterson, N. J.
Haskell-Dawes Machine Co., Philadelphia, Pa.
New England Butt Co., Division of Wanskuck Co., Providence, R. I.
Niehaus, K. A., Maschinenfabrik, Dusseldorf-Rath, Germany
Syncro Machine Co., Perth Amboy, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Capstans (See Capstans and Machinery—Winding Wire)

MACHINERY—Centerless Grinding & Polishing
American Laubscher Corp., New York, N. Y.

MACHINERY—Chain Link Fence
Norton & Co., Ltd., Sir James Farmer, Manchester, England
Pan American Supply Co., Long Island City, N. Y.
Wafios Machinery Corp., Hackensack, N. J.

MACHINERY—Chain Making
Pan American Supply Co., Long Island City, N. Y.
Wafios Machinery Corp., Hackensack, N. J.

MACHINERY—Closing Cable
Miyazaki Iron Works, Ltd., Osaka, Japan
Niehaus, K. A. Maschinenfabrik, Dusseldorf-Rath, Germany
Watson Machine Co., Paterson, N. J.

MACHINERY—Coiling Rod
Coulter & MacKenzie Machine Co., Bridgeport, Conn.
Vaughn Mach'y Co., Cuyahoga Falls, Ohio
Waterbury-Farrel Fdy. & Mach. Co., Inc., Div. of Textron, Inc., Waterbury, Conn.

MACHINERY—Cold Forging
National Machinery Co., Tiffin, Ohio
Unitech Products, Inc., Hartford, Conn.

MACHINERY—Cold Heading
National Machinery Co., Tiffin, Ohio
REM Sales Incorporated, Subsidiary of The Robert E. Morris Co., West Hartford, Conn.
Straus-Artys Corp., Great Neck, N. Y.
Waterbury-Farrel Fdy. & Mach. Co., Inc., Div. of Textron, Inc., Waterbury, Conn.

MACHINERY—Copper Wire Drawing
Cook Mfg. Co., The, Paterson, N. J.
Herborn Machinery Corporation, Hackensack, N. J.
Johnson Machinery Co., Elizabeth, N. J.
Loma Machine Manufacturing Co., New York, N.Y.
Morgardshammars Mek Verkstads A. B., Morgardshammar, Sweden
National Mach'y Exch., (Used), New York
Showa Machine Works, Ltd., Osaka, Japan
Straus-Artys Corp., Great Neck, N. Y.
Syncro Machine Co., Perth Amboy, N. J.
Torrington Manufacturing Co., Torrington, Conn.
Vaughn Machinery Co., Cuyahoga Falls, Ohio
Waterbury-Farrel Fdy. & Mach. Co., Inc., Div. of Textron, Inc., Waterbury, Conn.
Watkins & Sons, Inc., R. S., Sandy Hook, Conn.
Whitacre Corporation, Alhambra, California

MACHINERY—Covering Wire (See MACHINERY—Insulating Wire)
Eisler Engineering Company, Newark, N. J.
Lewis Machine Co., The, Cleveland, Ohio
Mettler Machine Tool, Inc., New Haven, Conn.
Wire Machinery, Inc., Chicago, Ill.

MACHINERY—Cutters, Hydraulic for Rod & Bar
Manco Mfg. Co., Bradley, Ill.
Porter, H. K., Inc., Somerville, Mass.

MACHINERY—Dead Block (Stationary Coiler)
Morgan Construction Co., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, Ohio
Wells Company, Frank L., Kenosha, Wisc.
Whitacre Corporation, Alhambra, California
Wire Machinery, Inc., Chicago, Ill.

MACHINERY—Descaling Rod, Dry
Coulter & McKenzie Machine Co., Bridgeport, Conn.
Fisher Associates, New York, N. Y.
Herborn Machinery Corporation, Hackensack, N. J.
Pangborn Corporation, Hagerstown, Md.
Wheelabrator Corporation, Mishawaka, Ind.
Wire Machinery, Inc., Chicago, Ill.

MACHINERY—Diameter Control
Muirhead Instruments Inc. (Addison Electric Co., Ltd.) New York, N. Y.

MACHINERY—Die Making
Alabama Wire Die Co., Fayette, Ala.
Boulin, Victor J., Inc., New York, N. Y.
Dykrex Corp., Roos Tool & Mfg. Div., Newark, N. J.
Indiana Wire Die Co., Ft. Wayne, Ind.
Metallurgical Products Dept. of General Electric Co., Detroit, Mich.
Sjogren Tool & Machine Co., Auburn, Mass.
Wayne Wire Die Co., Linden, N. J.

MACHINERY—Draw Benches
American Laubscher Corp., New York, N. Y.

Gavlick Machinery Corporation, Bridgeport, Conn.
Loma Machine Manufacturing Co., New York, N. Y.
Morgan Construction Co., Worcester, Mass.
Torrington Manufacturing Co., Torrington, Conn.
Vaughn Mach'y Co., Cuyahoga Falls, Ohio
Wire Machinery, Inc., Chicago, Ill.

MACHINERY—Eccentricity Control
Muirhead Instruments Inc. (Addison Electric Co., Ltd.) New York, N. Y.

MACHINERY—Edging (See MACHINERY—Tandem Rolling and Edging Mills)

MACHINERY—Enameling
Acrometal Products, Inc., Minneapolis, Minn.
American Insulating Mach'y Co., Phila., Pa.
Cook Mfg. Co., The, Paterson, N. J.

MACHINERY—Extruding
Davis-Standard Division of Franklin Research and Development Corporation, Mystic, Conn.
General Engineering (Radcliffe) Co., Ltd., Manchester, England
Johnson Machinery Co., Elizabeth, N. J.
Royle, John, & Sons, Paterson, N. J.
Western Wire & Textile Machinery, Inc., So. San Francisco, Calif.

MACHINERY—Fence
Glader, Wm., Machine Works, Chicago, Ill.
Norton & Co., Ltd., Sir James Farmer, Manchester, England
Wafios Machinery Corp., Hackensack, N. J.

MACHINERY—Flat Wire
Fenn Manufacturing Co., Newington, Conn.
Herborn Machinery Corporation, Hackensack, N. J.
Loma Machine Manufacturing Co., New York, N. Y.
Mettler Machine Tool, Inc., New Haven, Conn.
Stanat Mfg. Co., Inc., Westbury, L. I., N. Y.
Steel Equipment Company, Cleveland, Ohio
Torrington Manufacturing Co., Torrington, Conn.
Watkins & Sons, Inc., R. S., Sandy Hook, Conn.

MACHINERY—Forming Wire
Gavlick Machinery Corporation, Bridgeport, Conn.
National Mach'y Exch., (Used), New York, N. Y.
Pan American Supply Co., Long Island City, N. Y.
Straus-Artys Corp., Great Neck, N. Y.
Wafios Machinery Corp., Hackensack, N. J.

MACHINERY—Galvanizing Wire
Miyazaki Iron Works, Ltd., Osaka, Japan
Ofenbau Fritz G.m.b.H. & Co., K. G., Hagen, (W.-Germany)
Vaughn Mach'y Co., Cuyahoga Falls, Ohio
Whitacre Corporation, Alhambra, California
Wilson, Lee, Engr. Co., Cleveland, Ohio

MACHINERY—Gang Winders
Entwistle Manufacturing Corporation, Providence, R. I.

MACHINERY—Impregnation Control Paper Cables
Muirhead Instruments Inc. (Addison Electric Co., Ltd.) New York, N. Y.

MACHINERY—Insulating Wire
American Insulating Mach'y. Co., Phila., Pa.
Davis Electric Co., Wallingford, Conn.
Davis-Standard Division of Franklin Research and Development Corporation, Mystic, Conn.
Niehaus, K. A., Maschinenfabrik, Dusseldorf-Rath, Germany
Pourtier Pere et Fils, Romainville (Seine), France
Royle, John & Sons, Paterson, N. J.
Wardwell Braiding Machine Co., Central Falls, R. I.

MACHINERY—Insulation Testing (See MACHINERY—Spark Testing)

MACHINERY—Lacquering Electric Wire
Cook Mfg. Co., The, Paterson, N. J.

MACHINERY—Lock Washer
Wafios Machinery Corp., Hackensack, N. J.

MACHINERY—Looms, Wire Weaving
EVG., Machinen & Stahl, A. G., Zurich, Switzerland

MACHINERY—Material Handling
(See Material Handling Equipment)

MACHINERY—Measuring Wire & Cable
Davis Electric Co., Wallingford, Conn.
Durant Mfg. Co., Milwaukee, Wisc.
Entwistle Manufacturing Corporation, Providence, R. I.
Federal Manufacturing Company, Wallingford, Conn.
General Engineering (Radcliffe) Co., Ltd., Manchester, England
Muirhead Instruments Inc. (Addison Electric Co., Ltd.) New York, N. Y.
New England Butt Co., Division Wanskuck Co., Providence, R. I.
Standard Mill Supply Co., Pawtucket, R. I.

MACHINERY—Measuring and Control—Coating
Davis-Standard, Div. of Franklin Research and Development Corp., Mystic, Conn.

MACHINERY—Nail and Tack
Glader, Wm., Machine Works, Chicago, Ill.
National Machinery Co., Tiffin, Ohio
National Mach'y Exch. (Used), N.Y., N.Y.
Pan American Supply Co., Long Island City, N. Y.
Tanisaka Iron Works Ltd., Amagaski, Hyogo, Japan
Wafios Machinery Corp., Hackensack, N. J.

MACHINERY—Packaging Wire
Coulter & McKenzie Machine Co., Bridgeport, Conn.
Vaughn Machinery Co., Cuyahoga Falls, Ohio
Whitacre Corporation, Alhambra, California

MACHINERY—Patenting Wire
Ofenbau Fritz G.m.b.H. & Co., K. G., Hagen, (W.-Germany)
Vaughn Machinery Co., Cuyahoga Falls, Ohio
Whitacre Corporation, Alhambra, California

MACHINERY—Pin
REM Sales Incorporated, Subsidiary of The Robert E. Morris Company, West Hartford, Conn.

MACHINERY—Plating
Bartell Machine Tool Corp., Rome, N. Y.
Universal Industrial Equipment Co., Secaucus, N. J.

MACHINERY—Pointing
Herborn Machinery Corporation, Hackensack, N. J.
Morgan Construction Co., Worcester, Mass.
National Mach'y Exch., (Used), New York, N. Y.
Scudder, E. J., Fdry. & Mach. Co., Trenton, N. J.
Straus-Artys Corp., Great Neck, N. Y.
Syncro Machine Co., Perth Amboy, N. J.
Vaughn Mach'y Co., Cuyahoga Falls, Ohio
Waterbury-Farrel Fdy. & Mach. Co., Inc., Div. of Textron, Inc., Waterbury, Conn.

MACHINERY—Preheaters, Wire
Federal Manufacturing Company, Wallingford, Conn.
Walco Electric Co., Providence, R. I.

MACHINERY—Printing on Electric Wire
Entwistle Manufacturing Corporation, Providence, R. I.
Gem Gravure Co., West Hanover, Mass.
Gillies, Duncan M., Co., Inc., West Boylston, Mass.

MACHINERY—Re-Spooling
Acrometal Products, Inc., Minneapolis, Minn.
Bartell Machine Tool Corp., Rome, N. Y.
Coulter & McKenzie Machine Co., Bridgeport, Conn.
Davis Electric Co., Wallingford, Conn.
Emory Company, Robert J., Newark, N. J.
Entwistle Manufacturing Corporation, Providence, R. I.
Federal Manufacturing Company, Wallingford, Conn.
Herborn Machinery Corporation, Hackensack, N. J.
Miyazaki Iron Works, Ltd., Osaka, Japan
National Mach'y Exch. (Used), New York, N. Y.
Western Wire & Textile Machinery, Inc., So. San Francisco, Calif.
Wire & Textile Mach'y Inc., (used), Pawtucket, R. I.

MACHINERY—Rod Mill
Herborn Machinery Corporation, Hackensack, N. J.
Morgan Construction Co., Worcester, Mass.

MACHINERY—Rolling Mill
Fenn Manufacturing Co., Newington, Conn.
Loma Machine Manufacturing Co., New York, N. Y.
Morgan Construction Co., Worcester, Mass.
Stanat Mfg. Co., Inc., Westbury, L. I., N. Y.
Waterbury-Farrel Fdy. & Mach. Co., Inc., Div. of Textron, Inc., Waterbury, Conn.
Watkins & Sons, Inc., R. S., Sandy Hook, Conn.

MACHINERY—Rubber Insulating
Davis-Standard Division of Franklin Research and Development Corporation, Mystic, Conn.
Royle, John & Sons, Paterson, N. J.
Western Wire & Textile Machinery, Inc., So. San Francisco, Calif.
Wire & Textile Mach'y Inc., (used), Pawtucket, R. I.

MACHINERY—Serving
Pourtier Pere et Fils, Romainville (Seine), France
Wardwell Braiding Machine Co., Central Falls, R. I.

MACHINERY—Slitting Mills
Stanat Mfg. Co., Inc., Westbury, L. I., N. Y.
Steel Equipment Company, Cleveland, Ohio

MACHINERY—Spark Testing
Muirhead Instruments Inc. (Addison Electric Co., Ltd.) New York, N. Y.

MACHINERY—Special
American Machinery Co., Inc., Mentor, Ohio
Stanat Mfg. Co., Inc., Westbury, L. I., N. Y.
Watkins & Sons, Inc., R. S., Sandy Hook, Conn.

MACHINERY—Spring Making
Gavlick Machinery Corporation, Bridgeport, Conn.
National Mach'y Exch., (Used), New York, N. Y.
Pan American Supply Co., Long Island City, N. Y.
Torrington Manufacturing Co., Torrington, Conn.
Wafios Machinery Corp., Hackensack, N. J.
Wells Company, Frank L., Kenosha, Wisc.

MACHINERY—Straightening & Cutting
American Laubscher Corp., New York, N. Y.
Gavlick Machinery Corporation, Bridgeport, Conn.
Johnson Machinery Co., Elizabeth, N. J.
Lewis Machine Co., The, Cleveland, Ohio
Loma Machine Manufacturing Co., New York, N. Y.
Mettler Machine Tool Co., New Haven, Conn.
National Mach'y Exch. (Used), New York, N.Y.
Pan American Supply Co., Long Island City, N. Y.
Patterson Machine Co., The Geo. C., Cleveland, Ohio
Vaughn Machinery Co., Cuyahoga Falls, Ohio
Wafios Machinery Corp., Hackensack, N. J.
Wells Company, Frank L., Kenosha, Wisc.

MACHINERY—Stranding
Bartell Machine Tool Corp., Rome, N. Y.
Haskell-Dawes Machine Co., Phila., Pa.
Johnson Machinery Co., Elizabeth, N. J.
Miyazaki Iron Works, Ltd., Osaka, Japan
New England Butt Co., Division Wanskuck Co., Providence, R. I.
Niehaus, K. A., Maschinenfabrik, Dusseldorf-Rath, Germany
Stanat Mfg. Co., Inc., Westbury, L. I., N. Y.
Superior Tool & Manufacturing Company, Worcester, Mass.
Syncro Machine Co., Perth Amboy, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Swaging
Fenn Manufacturing Co., Newington, Conn.
Gavlick Machinery Corporation, Bridgeport, Conn.

MACHINERY—Tandem Rolling & Edging Mills
Fenn Manufacturing Co., Newington, Conn.
Loma Machine Manufacturing Co., New York, N. Y.
Stanat Mfg. Co., Inc., Westbury, L. I., N. Y.

MACHINERY—Take-Up and Pay-Out
Acrometal Products, Inc., Minneapolis, Minn.
American Insulating Mach'y Co., Phila., Pa.
Bartell Machine Tool Corp., Rome, N. Y.
Colbourne Machine Company, Winsted, Conn.
Coulter & McKenzie Machine Co., Bridgeport, Conn.
Davis Electric Co., Wallingford, Conn.
Davis-Standard Division of Franklin Research and Development Corporation, Mystic, Conn.
Entwistle Manufacturing Corporation, Providence, R. I.
Federal Manufacturing Company, Wallingford, Conn.
Fenn Manufacturing Co., Newington, Conn.
General Engineering (Radcliffe) Co., Ltd., Manchester, England
Johnson Machinery Co., Elizabeth, N. J.
Miyazaki Iron Works, Ltd., Osaka, Japan
Niehaus, K. A., Maschinenfabrik, Dusseldorf-Rath, Germany
Pourtier Pere et Fils, Romainville (Seine) France
Stanat Mfg. Co., Inc., Westbury, L. I., N. Y.
Standard Mill Supply Co., Pawtucket, R. I.
Steel Equipment Company, Cleveland, Ohio
Tanisaka Iron Works Ltd., Amagaski, Hyogo, Japan
Vaughn Machinery Co., Cuyahoga Falls, Ohio
Wardwell Braiding Machine Co., Central Falls, R. I.
Watson Machine Co., Paterson, N. J.
Whitacre Corporation, Alhambra, California

MACHINERY—Taping
American Insulating Mach'y Co., Phila., Pa.
New England Butt Co., Division Wanskuck Co., Providence, R. I.
Niehaus, K. A., Maschinenfabrik, Dusseldorf-Rath, Germany
Pourtier Pere et Fils, Romainville (Seine) France
Syncro Machine Co., Perth Amboy, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Thread Rolling
Mettler Machine Tool, Inc., New Haven, Conn.
Prutton Corporation, Cleveland, Ohio
Straus-Artys Corp., Great Neck, N. Y.
Waterbury-Farrel Fdy. & Mach. Co., Inc., Div. of Textron, Inc., Waterbury, Conn.
Wire Machinery, Inc., Chicago, Ill.

MACHINERY—Tinning Wire
American Insuating Mach'y Co., Phila., Pa.
Cook Mfg. Co., The, Paterson, N. J.

Ofenbau Fritz G.m.b.H. & Co. K. G., Hagen, (W.-Germany)
Universal Industrial Equipment Co., Secaucus, N. J.
Whitacre Corporation, Alhambra, California

MACHINERY—Tinsel Rolling Mills
American Insulating Mach'y Co., Phila., Pa.

MACHINERY—Trolley Wire
Torrington Manufacturing Co., Torrington, Conn.
Vaughn Machinery Co., Cuyahoga Falls, Ohio

MACHINERY—Tube Mill, Cold Drawing
Johnson Machinery Co., Elizabeth, N. J.
Loma Machine Manufacturing Co., New York, N. Y.
Mettler Machine Tool, Inc., New Haven, Conn.

MACHINERY—Twinning
(See Mach.—Bunching)

MACHINERY—Twisters, Wire
Cook Manufacturing Co., The, Paterson, N.J.
Edmands Company, The, Cranston, R. I.
Haskell-Dawes Machine Co., Philadelphia, Pa.

MACHINERY—Used
Gavlick Machinery Corporation, Bridgeport, Conn.
Johnson Machinery Co., Elizabeth, N. J.
National Machinery Exchange, New York, N. Y.
Wire & Textile Machy., Inc., Pawtucket, R. I.
Wire Machinery, Inc., Chicago, Ill.

MACHINERY—Variable Speed Drives
Allis Co., Louis, Milwaukee, Wisc.

MACHINERY—Welded Wire Mesh
EVG, Maschinen and Stahl, A.G., Zurich, Switzerland
Schlatter, Ltd., H.A., Zollikon, Zurich

MACHINERY—for Wire Welding
(See WELDERS—Butt and Spot and Machinery—Welding Wire Fabrics)

MACHINERY—Winding Wire
Davis Electric Co., Wallingford, Conn.
Davis-Standard Div. of Franklin Research and Development Corp., Mystic, Conn.
Emory Company, Robert J., Newark, N. J.
Federal Manufacturing Company, Wallingford, Conn.
Miyazaki Iron Works, Ltd., Osaka, Japan
New England Butt Co., Division Wanskuck Co., Providence, R. I.
Niehaus, K. A., Maschinenfabrik, Dusseldorf-Rath, Germany
Standard Mill Supply Co., Pawtucket, R. I.
Steel Equipment Company, Cleveland, Ohio
Straus-Artys Corp., Great Neck, N. Y.

MACHINERY—Wire Drawing
American Laubscher Corporation, New York, N. Y.
Cook Manufacturing Co., The, Paterson, N.J.
Coulter & McKenzie Machine Co., Bridgeport, Conn
Fenn Manufacturing Co., Newington, Conn.
Gavlick Machinery Corporation, Bridgeport, Conn.
Herborn Machinery Corporation, Hackensack, N. J.
Johnson Machinery Co., Elizabeth, N. J.
Loma Machine Manufacturing Co., New York, N. Y.
Miyazaki Iron Works, Ltd., Osaka, Japan
Morgan Construction Co., Worcester, Mass.
Morgardshammars Mek Verkstads AB, Morgardshammar, Sweden
National Mach'y Exch. (Used), New York, N. Y.
Norton & Co., Ltd., Sir James Farmer, Manchester, England
Pan American Supply Co., Long Island City, N. Y.
Scudder, E. J., Fdry. & Mach. Co., Trenton, N. J.
Showa Machine Works Ltd., Osaka, Japan
Societa Generale Delle Macchine Mill, Milan, Italy
Stanat Mfg. Co., Inc., Westbury, L. I., N. Y.
Straus-Artys Corp., Great Neck, N. Y.
Superior Tool & Machinery Company, Worcester, Mass.
Syncro Machine Co., Perth Amboy, N. J.
Tanisaka Iron Works Ltd., Amagaski, Hyogo, Japan
Vaughn Mach'y Co., Cuyahoga Falls, Ohio
Wartenweiler, Emilio, Milano, Italy—SAMP
Waterbury-Farrel Fdy. & Mach. Co., Inc., Div. of Textron, Inc., Waterbury, Conn.
Watkins & Sons, Inc. R. S., Sandy Hook, Conn.
Whitacre Corporation, Alhambra, California
Wire Machinery Inc., Chicago, Ill.

MACHINERY—Wire Preheaters
Muirhead Instruments Inc. (Addison Electric Co., Ltd.) New York, N. Y.

MACHINERY—Wire Rope
Niehaus, K. A., Maschinenfabrik, Dusseldorf-Rath, Germany
Watson Machine Co., Paterson, N. J.

MACHINERY—Wrapping with Paper
American Laubscher Corp, New York, N. Y.
Larmuth (1947) Ltd., Cheshire, England

MATERIAL HANDLING EQUIPMENT—
Cleveland Tramrail Div. of The Cleveland Crane & Engineering Co., Wickliffe, Ohio

MOLYBDENUM-DISULFIDE—Lubricants
Climax Molybdenum Company, a division of American Metal Climax, Inc., New York, N. Y.

MOTORS—Electric
Allis Co., Louis, Milwaukee, Wisc.
Waico Electric Co., Providence, R. I.

NAIL TOOLING—Tungsten Carbide
Pittsburgh Carbide Die Co., Monongahela, Pa.

NAILS—Wire
Bethlehem Steel Co., Bethlehem, Pa.
Continental Steel Corp., Kokomo, Ind.
Keystone Steel & Wire Co., Peoria, Ill.
Wickwire Brothers, Inc., Cortland, N. Y.

NIPPERS—Wire Cutting
Robinson, M. W. Co., Rockfall, Conn.

NOZZLES—For Extruding Machines
Central Tool and Mach. Co., Bridgeport, Conn.

OVENS—Cable Lacquering and Enameling
American Insulating Mach'y Co., Phila., Pa.
Carl Mayer Corp., The, Cleveland, Ohio
Colbourne Machine Co., Winsted, Conn.

OVENS—Rod Bakers
Carl Mayer Corp., The, Cleveland, Ohio

OVENS—Welding Rod Coating
Carl Mayer Corp., The, Cleveland, Ohio

PAILS—Packaging
(See Drums—Wire Packaging)

PAPER—Coil Wrapping
Ludlow Corporation, Needham Heights, Mass.

PAPER—Insulating
Ludlow Corporation, Needham Heights, Mass.
Twitchell, Inc., E. W., Philadelphia, Pa.

PAY-OUT SYSTEMS—
(See MACHINERY—Take-Up & Pay-Out)

PHOSPHATE COATING CHEMICALS
(See COMPOUNDS—Phosphate Coating)

PICKLING COMPOUNDS—
See (Inhibitors—Pickling)

PLASTICIZERS—
Kenrich Petrochemicals, Inc., Maspeth, N. Y.
Monsanto Chemical Company, Plastics Division, Springfield, Mass.

PLASTICS—for Wire Insulation
Blane Corporation, The, Canton, Mass.
Chemical Products Corporation, E. Providence, R. I.
Dow Corning Corporation, Midland, Mich.
Kenrich Petrochemicals, Inc., Maspeth, N. Y.
Monsanto Chemical Company, Plastics Division, Springfield, Mass.
Union Carbide Plastics Company, Div. of Union Carbide Corporation, New York, N. Y.

PREHEATERS—Wire
Federal Manufacturing Company, Wallingford, Conn.
Muirhead Instruments Inc. (Addison Electric Co., Ltd.) New York, N. Y.
Waico Electric Co., Providence, R. I.

PRINTING WHEELS—for Electric Wire
Entwistle Manufacturing Corporation, Providence, R. I.
Gem Gravure Co., Inc., West Hanover, Mass.
Gillies, Duncan M., Co., Inc., West Boylston, Mass.

PULLERS AND GRIPS—for Wire
Morgan Construction Co., Worcester, Mass.
Scudder, E. J. Fdry. & Mach. Co., Trenton, N. J.
Sjogren Tool & Mach. Co., Auburn, Mass.

RACKS—Wire Storage
Jarke Manufacturing Co., Chicago, Illinois

REEL AND TENSION STANDS—
Acrometal Products, Inc., Minneapolis, Minn.
Mettler Machine Tool, Inc., New Haven, Conn.
Standard Mill Supply Co., Pawtucket, R. I.
Wardwell Braiding Machine Co., Central Falls, R. I.

REELS & SPOOLS—Aluminum Alloy
Acrometal Products, Inc., Minneapolis, Minn.
Hubbard Spool Company Div., Van Norman Industries, Inc., Garrett, Ind.
Merrimac Spool & Reel Co., Inc., Haverhill, Mass.
Wardwell Braiding Machine Co., Central Falls, R. I.

REELS & SPOOLS—Annealing and Stranding
Acrometal Products, Inc., Minneapolis, Minn.
Apco Mossberg Co., Attleboro, Mass.
Hubbard Spool Company Div., Van Norman Industries, Inc., Garrett, Ind.
Mossberg Pressed Steel Corp., Division of Wanskuck Co., Attleboro, Mass.
Republic Steel Corp., Berger Div., Canton, Ohio

REELS & SPOOLS—Custom Made
Merrimac Spool & Reel Co., Inc., Haverhill, Mass.

REELS—Metal Bound
Durkee Mfg. Co., Inc., Pine River, Minn.
Hubbard Spool Company Div., Van Norman Industries, Inc., Garrett, Ind.

REELS—Plywood
Antrim Reel, Inc., Haverhill, Mass.
Carris Reels, Inc., Rutland, Vermont
Hubbard Spool Company Div., Van Norman Industries, Inc., Garrett, Ind.

REELS & SPOOLS—Steel (All Types)
Acrometal Products, Inc., Minneapolis, Minn.
Apco Mossberg Co., Attleboro, Mass.
Carlton Manufacturing Co., Pawtucket, R. I.
Clark Manufacturing Co., J. L., Rockford, Illinois
Hubbard Spool Company Div., Van Norman Industries, Inc., Garrett, Ind.
Merrimac Spool & Reel Co., Inc., Haverhill, Mass.
Mossberg Pressed Steel Corp., Division of Wanskuck Co., Attleboro, Mass.
Republic Steel Corp., Berger Div., Canton, Ohio
Wardwell Braiding Machine Co., Central Falls, R. I.

REELS—Wire Mill
Acrometal Products, Inc., Minneapolis, Minn.
Apco Mossberg Co., Attleboro, Mass.
Bridge Mfg. Co., The, Hazardville, Conn.
Carris Reels, Inc., Rutland, Vermont
Durkee Mfg. Co. Inc., Pine River, Minn.
Hubbard Spool Company Div., Van Norman Industries, Inc., Garrett, Ind.
Mossberg Pressed Steel Corp., Division of Wanskuck Co., Attleboro, Mass.
Nelson Co., The, Baltimore, Md.
Republic Steel Corp., Berger Div., Canton, Ohio
Wardwell Braiding Machine Co., Central Falls, R. I.

REELS & SPOOLS—Wood
Antrim Reel, Inc., Haverhill, Mass.
Bridge Mfg. Co., The, Hazardville, Conn.
Carris Reels, Inc., Rutland, Vermont
Durkee Mfg. Co., Inc., Pine River, Minn.
Hubbard Spool Company Div., Van Norman Industries, Inc., Garrett, Ind.
Nelson Co., The, Baltimore, Md.

ROD BAKERS—
(See OVENS—Rod Bakers)

RODS—Stainless Steel
Western Wire Corporation, Boston, Mass.

RODS—Wire—Non-Ferrous
Platt Bros. & Co., The, Waterbury, Conn.

RODS—Steel
Bethlehem Steel Co., Bethlehem, Pa.
Colorado Fuel and Iron Corporation, Denver, Oakland & New York City.
Continental Steel Corp., Kokomo, Ind.
Detroit Steel Corporation, Detroit, Mich.
Eaton Mfg. Co., Massillon, Ohio
Keystone Steel & Wire Co., Peoria, Ill.
Niederrheinische Huette, A. G., Duisburg, Germany
Northwestern Steel & Wire Co., Sterling, Illinois
Sumitomo Metal Industries, Ltd., Osaka, Japan
Wickwire Spencer Steel Div., Colorado Fuel & Iron Corp., New York, N. Y.
Yawata Iron & Steel Co., Ltd., Tokyo, Japan

ROPE—Wire
American Chain & Cable Co., Page Steel & Wire Div., Monessen, Pa.
Bethlehem Steel Co., Bethlehem, Pa.
Roebling's, John A. Sons, Div., Colorado Fuel & Iron Corp., Trenton, N. J.

RUST PROOF COMPOUNDS—
(See COMPOUNDS—RUST Removing)

RUST REMOVING COMPOUNDS—
(See COMPOUNDS—RUST Preventing)

SCRAP WIRE—Bare or Insulated, Bought
Electro Metals Separation Co. Div. of M. J. Stavola & Co., Inc., Danbury, Conn.

SILICONE RUBBER—For Wire Insulation
Dow Corning Corporation, Midland, Mich.

SOAPS—Industrial and Wire Drawing
(See COMPOUNDS—Wire Drawing)

SPOOLS—For Retail Sale of Wire
Antrim Reel, Inc., Haverhill, Mass.
Carlton Manufacturing Co., Pawtucket, R. I.
Clark Manufacturing Co., J. L., Rockford, Illinois

SPOOLS—Paper
Merrimac Spool & Reel Co., Inc., Haverhill, Mass.

SPOOLS—Plastic
Hubbard Spool Company Div., Van Norman Industries, Inc., Garrett, Ind.
Merrimac Spool & Reel Co., Inc., Haverhill, Mass.
Plastic Mold & Eng. Co., Providence, R. I.
Standard Mill Supply Co., Pawtucket, R. I.

STAMPINGS—Steel
Mossberg Pressed Steel Corp., Division of Wanskuck Co., Attleboro, Mass.

STOCK STORAGE SYSTEMS—
Jarke Manufacturing Co., Chicago, Illinois

STRAND—Galvanized Steel
Southwire Co., Carrollton, Ga.

STRIP—Steel
Bethlehem Steel Co., Bethlehem, Pa.
Continental Steel Corp., Kokomo, Ind.
Jones & Laughlin Steel Corporation, Pittsburgh, Pa.

Roebling's, John A. Sons Div., Colorado Fuel & Iron Corp., Trenton, N. J.

TANKS—Ceramic, for Galvanizing
Ofenbau Fritz G.m.b.H. & Co. K. G., Hagen, (W.-Germany)

TENSION METERS—for Wire
Boulin Instrument Corp., Pelham, N. Y.
Tensitron, Inc., Harvard, Mass.

TESTERS—INSULATION
(See Testing Equipment—for Dielectric Faults)

TESTING EQUIPMENT—Dielectric Faults in Insulation
Davis Electric Co., Wallingford, Conn.
Entwistle Manufacturing Corporation, Providence, R. I.
Federal Manufacturing Company, Wallingford, Conn.
Muirhead Instruments Inc. (Addison Electric Co., Ltd.) New York, N. Y.

TESTING EQUIPMENT—Physical
Scott Testers, Inc., Providence, R. I.
Steele Company, M. G., Rome, N. Y.

TINSEL—Electric Conductor
Montgomery Co., The, Windsor Locks, Conn.

TINSEL WIRE—Resistance, Lame, Decorative Cords Thread—Bare Copper Silver and False Gold Coated, etc.
(See TINSEL-Electric Conductor)

TOOLS—Nail Machine
Pittsburgh Carbide Die Co., Monongahela, Pa.

TRAMRAIL SYSTEMS—
Cleveland Tramrail Div. of the Cleveland Crane & Engineering Co., Wickliffe, Ohio

TRANSMISSIONS—Variable Speed (See Adjustable Speed Drives)

TRAVERSE & DRUMS—For Reels
(See Drums & Traverses)

TRAVERSE MECHANISMS—
Davis Electric Co., Wallingford, Conn.
Emory Company, Robert J., Newark, N. J.
Western Wire & Textile Machinery, Inc., So. San Francisco, Calif.

VARNISHES & LACQUERS—for Electric Wire
Chemical Products Corporation, E. Providence, R. I.
General Electric Company, Insulating Materials Section, Schenectady, N. Y.

VULCANIZING PANS AND EQUIPMENT—
American Insulating Mach'y Co., Phila., Pa.
Mossberg Pressed Steel Corp., Division of Wanskuck Co., Attleboro, Mass.

WELDERS—Spot and Butt and Welding Wire Fabrics
Eisler Engineering Corp., Newark, N. J.
EVG, Maschinen and Stahl, A.G., Zurich, Switzerland
Herborn Machinery Corporation, Hackensack, N. J.
Micro Products Co., Chicago, Ill.
Schlatter, Ltd., H.A., Zollikon, Zurich

WHEELS—for Printing on Electric Wire
Gem Gravure Company, West Hanover, Mass.
Gillies, Duncan M., Co., Inc., West Boylston, Mass.

WIRE—ACSR
Southwire Co., Carrollton, Ga.

WIRE—Aluminum
Malin & Co., The, Cleveland, Ohio
Southwire Co., Carrollton, Ga.

WIRE—Ball
Webb Wire Div. Carpenter Steel Co., New Brunswick, N. J.

WIRE—Ball & Roller Bearing
Eaton Mfg. Co., Massillon, Ohio

WIRE—Brass and Bronze
Malin & Co., The, Cleveland, Ohio

WIRE—Brush
Maryland Fine & Specialty Wire Co., Inc., Cockeysville, Md.

WIRE—Building, Electric
Southwire Co., Carrollton, Ga.

WIRE—Bunched and Stranded
Camden Wire Co., Camden, N. Y.
Laribee Wire, Inc., Camden, N. Y.

WIRE—Cadmium
Stamford Processing Co., Peekskill, N. Y.

WIRE—Cold Heading
Bethlehem Steel Co., Bethlehem, Pa.
Colorado Fuel and Iron Corporation, Denver, Oakland & New York City.
Continental Steel Corp., Kokomo, Ind.
Detroit Steel Corporation, Detroit, Mich.
Keystone Steel & Wire Co., Peoria, Ill.
Maryland Fine & Specialty Wire Co., Inc., Cockeysville, Md.
Pittsburgh Steel Co., Pittsburgh, Pa.
Western Wire Corporation, Boston, Mass.
Wickwire Spencer Steel Div., The Colorado Fuel & Iron Corp., New York, N. Y.

WIRE—Copper
Camden Wire Co., Camden, N. Y.
Laribee Wire, Inc., Camden, N. Y.
Malin & Co., The, Cleveland, Ohio
Southwire Co., Carrollton, Ga.

WIRE—Coppered Stainless Steel
Western Wire Corporation, Boston, Mass.

WIRE—For Electrical Conductors
Camden Wire Co., Camden, N. Y.
Laribee Wire, Inc., Camden, N. Y.

WIRE—Flat
American Chain & Cable Co., Page Steel & Wire Div., Monessen, Pa.
Colorado Fuel and Iron Corporation, Denver, Oakland & New York City.
Montgomery Co., The, Windsor Locks, Conn.
Webb Wire Div. Carpenter Steel Co., New Brunswick, N. J.

WIRE—Galvanized
Colorado Fuel and Iron Corporation, Denver, Oakland & New York City.
Detroit Steel Corporation, Detroit, Mich.
Northwestern Steel & Wire Co., Sterling, Illinois
Roebling's, John A. Sons Div., Colorado Fuel & Iron Corp., Trenton, N. J.
Wickwire Spencer Steel Div., Colorado Fuel & Iron Corp., New York, N. Y.

WIRE—High Carbon
American Chain & Cable Co., Page Steel & Wire Div., Monessen, Pa.
Detroit Steel Corporation, Detroit, Mich.
Maryland Fine & Specialty Wire Co., Inc., Cockeysville, Md.
Webb Wire Div., Carpenter Steel Co., New Brunswick, N. J.

WIRE—Insulated
Southwire Co., Carrollton, Ga.

WIRE—Manufacturers
American Chain & Cable Co., Page Steel & Wire Div., Monessen, Pa.
Bethlehem Steel Co., Bethlehem, Pa.
Colorado Fuel and Iron Corporation, Denver, Oakland & New York City.
Continental Steel Corp., Kokomo, Ind.
Detroit Steel Corporation, Detroit, Mich.
Keystone Steel & Wire Co., Peoria, Ill.
Maryland Fine & Specialty Wire Co., Inc., Cockeysville, Md.
Northwestern Steel & Wire Co., Sterling, Illinois
Pittsburgh Steel Co., Pittsburgh, Pa.
Republic Steel Corp., Berger Div., Canton, Ohio
Roebling's, John A., Sons Div., Colorado Fuel & Iron Corp., Trenton, N. J.
Rylands Brothers Limited, Warrington, England
U. S. Steel Corp., N. Y., N. Y.
Webb Wire Div., Carpenter Steel Co., New Brunswick, N. J.
Wickwire Brothers, Inc., Cortland, N. Y.
Wickwire Spencer Steel Div., The Colorado Fuel & Iron Corp., New York, N. Y.

WIRE—Metalizing
American Chain & Cable Co., Page Steel & Wire Div., Monessen, Pa.
Platt Bros. & Co., The, Waterbury, Conn.
Stamford Processing Co., Peekskill, N. Y.

WIRE—Music
Malin & Co., The, Cleveland, Ohio

WIRE—Needle
Webb Wire Div., Carpenter Steel Co., New Brunswick, N. J.

WIRE—Nickel Alloy
Webb Wire Div., Carpenter Steel Co., New Brunswick, N. J.

WIRE—Nickel Silver and Phosphor Bronze
Malin & Co., The, Cleveland, Ohio

WIRE—Oil Tempered
Colorado Fuel and Iron Corporation, Denver, Oakland & New York City.
Detroit Steel Corporation, Detroit, Mich.
Malin & Co., The, Cleveland, Ohio
Pittsburgh Steel Co., Pittsburgh, Pa.
Roebling's, John A., Sons Div., Colorado Fuel & Iron Corp., Trenton, N. J.
Wickwire Spencer Steel Div., Colorado Fuel & Iron Corp., New York, N. Y.

WIRE—Preheaters
Walco Electric Co., Providence, R. I.

WIRE—for Prestressed Concrete
Rylands Brothers, Limited, Warrington, England

WIRE—Pin
Maryland Fine & Specialty Wire Co., Inc., Cockeysville, Md.

WIRE—Special Shapes
American Chain & Cable Co., Page Steel & Wire Div., Monessen, Pa.
Colorado Fuel and Iron Corporation, Denver, Oakland & New York City.
Continental Steel Corp., Kokomo, Ind.
Eaton Mfg. Co., Massillon, Ohio
Wickwire Spencer Steel Div., The Colorado Fuel & Iron Corp., New York, N. Y.

WIRE—Spring
American Chain & Cable Co., Page Steel & Wire Div., Monessen, Pa.
Bethlehem Steel Co., Bethlehem, Pa.
Colorado Fuel and Iron Corporation, Denver, Oakland & New York City.
Continental Steel Corp., Kokomo, Ind.
Keystone Steel & Wire Co., Peoria, Ill.
Maryland Fine & Specialty Wire Co., Inc., Cockeysville, Md.
Pittsburgh Steel Co., Pittsburgh, Pa.
Roebling's, John A., Sons Div., Colorado Fuel & Iron Corp., Trenton, N. J.
Webb Wire Div., Carpenter Steel Co., New Brunswick, N. J.
Wickwire Spencer Steel Div., The Colorado Fuel & Iron Corp., New York, N. Y.

WIRE—Stainless Steel
American Chain & Cable Co., Page Steel & Wire Div., Monessen, Pa.
Malin & Co., The, Cleveland, Ohio
Maryland Fine & Specialty Wire Co., Inc., Cockeysville, Md.
Nippon Stainless Steel Wire Mfg. Co., Ltd., Osaka, Japan.
Pittsburgh Steel Co., Pittsburgh, Pa.
Webb Wire Div., Carpenter Steel Co., New Brunswick, N. J.
Western Wire Corporation, Boston, Mass.

WIRE—Steel—Also Coppered and Galvanized Steel
Bethlehem Steel Co., Bethlehem, Pa.
Colorado Fuel and Iron Corporation, Denver, Oakland & New York City.
Continental Steel Corp., Kokomo, Ind.
Detroit Steel Corporation, Detroit, Mich.
Keystone Steel & Wire Co., Peoria, Ill.
Malin & Co., The, Cleveland, Ohio
Maryland Fine & Specialty Wire Co., Inc., Cockeysville, Md.
Northwestern Steel & Wire Co., Sterling, Illinois
Pittsburgh Steel Co., Pittsburgh, Pa.
Roebling's, John A., Sons Div., Colorado Fuel & Iron Corp., Trenton, N. J.
Rylands Brothers, Limited, Warrington, England
U. S. Steel Export Co., New York, N. Y.
Wickwire Brothers, Inc., Cortland, N. Y.
Wickwire Spencer Steel Div., The Colorado Fuel & Iron Corp., New York, N. Y.

WIRE—Straightening and Cutting
Colorado Fuel and Iron Corporation, Denver, Oakland & New York City.
Wickwire Brothers, Inc., Cortland, N. Y.
Wickwire Spencer Steel Div., Colorado Fuel & Iron Corp., New York, N. Y.

WIRE—Stranded & Bunched
Laribee Wire, Inc., Camden, N. Y.

WIRE—Tinned
Camden Wire Co., Camden, N. Y.
Laribee Wire, Inc., Camden, N. Y.

WIRE—Zinc
Platt Bros. & Co., The, Waterbury, Conn.
Stamford Processing Co., Peekskill, N. Y.

WRAPPING PAPER—Creped
(See PAPER-Creped Wrapping)

YARN TESTERS—
Scott Testers, Inc., Providence, R. I.

YARNS—Wire Insulating
Chadwick Yarn Company, Pawtucket, R. I.
Synthetic Thread Co., Bethlehem, Pa.

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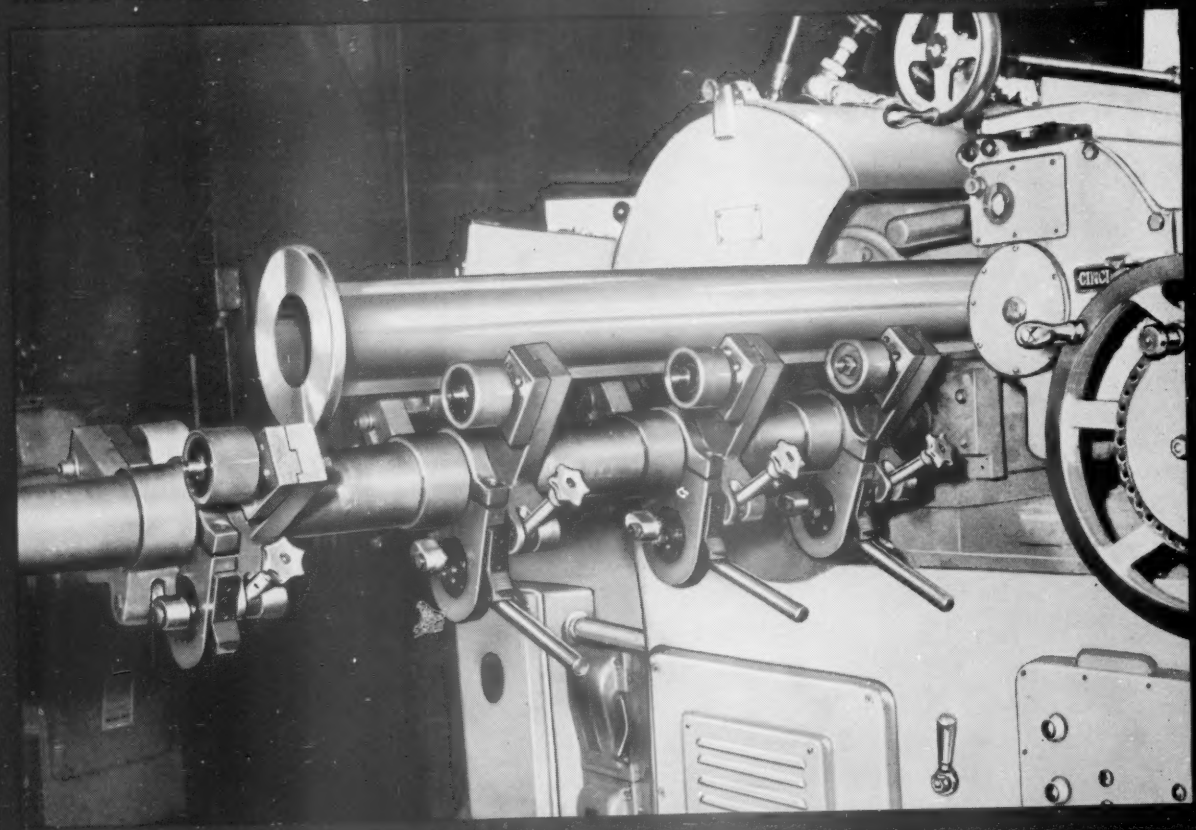
MORE THAN ONE DIAMETER . . . ON A CENTERLESS GRIN

(Patented) RETRACTABLE ROLLER BEARING ARMS NOW MAKE POSSIBLE O. D. GRINDI
WELL as CENTERLESS GRINDING of bar stock and tubing with the SAME FIXTURE!!



"O.D. GRINDING and POLISHING MADE EASIER" as it
INCREASES PRODUCTION up to 500% WITH PRECISION ACCURACY!!

A BAR STOCK FIXTURE THAT WHEN INCORPORATED WITH ANY CENTERLESS GRINDER, REGARDLESS OF MAKE, AND

WILL!!

Brochure and Factory Price List will be Mailed Complimentary on Request!!

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A. & B. CENTERLESS GRINDING COMPANY

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Industry's Finest! A. & B. TUBING AND BAR STOCK CENTERLESS GRINDER FIXTURE MAKES IT POSSIBLE TO GRIND FROM 1/8 TO 12 INCH O'D AND HOLD TOLERANCES OF PLUS OR MINUS .001 THE ENTIRE LENGTH OF 52 FEET

GRINDING AND POLISHING MADE EASIER!!

TO EVERY STEEL MILL, MACHINE SHOP, HYDRAULIC CYLINDER MANUFACTURER, TOOL SHOP OR ANY ONE THAT USES, BUYS OR SELLS STANDARD OR SPECIAL SIZE TUBING OR BAR STOCK MATERIAL REQUIRING A PRECISION GROUND OR POLISHED FINISH...

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WILL: Grind larger O'D sizes and longer lengths for a demanding market!

WILL: Make automation possible in steel mills and anywhere required!

WILL: Grind from one size to another with just a

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AND MASTICATING MACHINERY MANUFACTURERS

WATSON

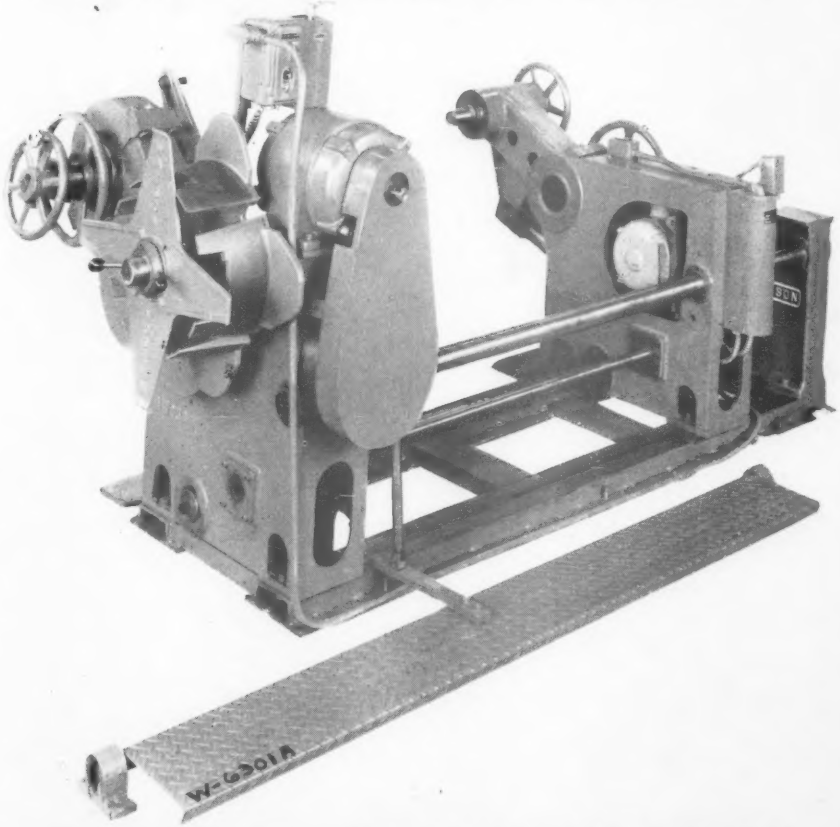
TYPE "R" DESIGNS

U. S. PATENT 2,909,339

"SHAFTLESS"

TAKEUPS -- COILING-REWINDERS -- LETOFFS

FOR REELS FROM 22" TO 84" FLANGE DIAMETER.
FOR ANY PRACTICAL WIDTH.
BASE FLUSH FOR FLOOR MOUNTING. — NO PITS REQUIRED.
FOR HEAVIEST DUTIES & LOADS. TRANSPOSABLE ASSEMBLIES.
MOTORIZED REEL LIFT — MECHANICAL FRAME SHIFT.
RETRACTABLE PINTLES WITH AUTOMATIC LOCK.
SEPARATE DOG DETRACTION.
ULTRA-RAPID AND EFFORTLESS MANIPULATION.



UNIT SHOWN IS A 60-INCH "R" COILING-REWINDER WITH
FOOT TREADLE DRIVE-BRAKE CONTROL AND COILING HEAD.

Our Design Aims: SAFETY — SIMPLICITY — PRODUCTIVITY

Here, There Can Be

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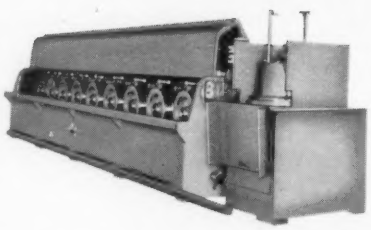
Like a giant spider web, transmission lines crisscross our country, supplying electric power to 180 million Americans. The ever increasing demand requires these copper and aluminum cables to carry electricity at potentials as high as 600,000 volts. Safe, efficient transmission of power at such high voltage, and under extreme variations of temperature, is another example where, in design and manufacture, there can be, "no compromise with quality." Suppliers of such cable rely on the name "SYNCRO," for machinery, that for over 31 years in the wire and wire products industry, has been synonymous with superiority. When we have the opportunity to serve your company, you can be sure that our philosophy too, is "NO COMPROMISE WITH QUALITY."



Syncro Model 18-T-10 Tandem Rod Breakdown Machine — maximum entering rod size is ½" soft copper with finished sizes ranging from #2 to #16 B&S gauge drawn at maximum finishing speeds.

This is only one of the outstanding wire drawing and cable mill machines in Syncro's complete line of machinery for the Wire Industry. For further information write to: Syncro Machine Company, Perth Amboy, New Jersey.

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